Initial Assessment of the Health and Condition of California's Lands and Natural Resources

2002

California Legacy Project

A Resource Conservation Strategy



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A draft of this report was distributed or made available via the Internet to the executive management, the management, and the stakeholder advisory committees of the California Legacy Project. The directors of Boards, Departments, Conservancies, and Commissions not represented on any of the above committees, as well as academic partners working with Legacy Project staff on a variety of data integration and synthesis activities also received copies for review. In addition to comments received from numerous committee members at advisory committee meetings, the comments received in writing from the following organizations were greatly appreciated: California Wildlife Conservation Board, California Department of Conservation, California Department of Fish and Game, California Department of Forestry and Fire Protection, San Francisco Bay Conservation and Development Commission, State Coastal Conservancy, California Department of Parks and Recreation, North Coast Watershed Assessment Program, California Cattleman's Association/Range Management Advisory Committee to the Board of Forestry, and the Irvine Company.

Executive Summary

The California Legacy Project is a unique statewide effort without parallel in the nation. It is charged with integrating conservation assessment and planning among five different objectives: (1) terrestrial biodiversity, (2) aquatic biodiversity and watershed values, (3) working landscapes, (4) recreation lands, and (5) urban open space. The Project developed this document as a part of a series of scheduled reports that the Resources Agency agreed to submit to the Joint Budget Committee of the California Legislature.

Decisions within each of the above conservation objectives typically affect the planning and policy choices in the other objectives. For example, decisions about developing conservation easements for high-value croplands near urbanizing areas affect where human population growth can be accommodated. Decisions about creating open space to improve the quality of life for underserved communities in the urban core may also benefit conservation goals for fish and wildlife. Decisions about linking isolated habitats through wildlife corridors may benefit recreation, ranching, and open-space goals, while limiting or re-directing other uses, such as new housing developments.

The land stewardship and management mandates of individual government departments are often focused on specific program or project areas that frequently have had the unintended effect of compartmentalizing decisions in isolation from one another. The demand for a holistic, statewide picture of the health and condition of California's landscapes and ecosystems is therefore growing, both within government and in the private conservation community.

The Project's integrated resource assessments will incrementally provide a firmer foundation for evaluating the optimal mix of conservation investments and implementation strategies. They also will be useful for documenting the conservation progress of agency programs according to adaptive management principles.

The Project's multiyear assessment effort and this current report stem from a science-based methodology that has been recently developed. The current report focuses on illustrating how the Legacy Project's methodology can be applied to describe conditions, stressors, and management responses for conserving biodiversity and working landscapes. It is also designed to stimulate discussions among agencies about important goals, indicators, and data improvements.

The report briefly summarizes the methodology used as a framework for the assessment and points out some of the important issues that the Legacy Project and its partners will need to address for full implementation. The methodology itself lays out an ambitious, but realistic work plan for assessing the health and condition of the state's lands and natural resources. Such an approach is possible as long as it is understood to be an incremental process that gradually provides more and better results with each iteration. The degree to which each assessment report improves depends on the level of collaboration achieved with state agencies, the degree with which existing assessment programs can answer statewide questions, and the level of funding for both the Legacy Project and other agency assessment programs.

The main body of the report summarizes current knowledge about some example indicators and provides maps to illustrate geographic differences across the state. The presentation of the information follows the key concepts in the methodology using condition, stressor, and response indicators. These are examples only, and more discussion is needed with other agencies to select the most appropriate indicators.

For the biodiversity objective, vegetation types and special-status species illustrate conditions. Stressors are shown by projected urban growth and road distribution. Management responses are illustrated by regional conservation planning efforts.

Two themes are used to illustrate working landscapes: forestlands and agricultural lands. For forestlands, conditions are illustrated by the distribution of forests and woodlands, stressors by changes in vegetative canopy cover, and management response by land enrollment in timber production zones. For agricultural lands, conditions are exemplified by the distribution of important farmlands and gross agricultural productivity; stressors are represented by farmland conversion, and responses by Williamson Act enrollments and agricultural easements.

Observations about each map, as well as comparison of patterns among maps, require more robust analysis before drawing conclusions to be used for evaluating strategic investment and management options. The report describes several options for these types of future analyses, which can be addressed with continued and increased funding. Some of these analyses are in progress by other state agency assessment programs, and their results will be integrated into future assessment reports. Each section also provides suggestions for other types of indicators that agencies can use for informing their management decisions.

In addition, the report identifies the important next steps for implementing the methodology. One key step is to conduct more discussion and continue to improve partnerships with natural resource agencies to identify goals, benchmarks, and indicators. Another key step is to improve the basic data and to conduct more robust analyses. This will require continued and expanded funding for both the Legacy Project as well as assessment programs within agencies.

The report provides several obvious conclusions about the status and trends of lands and natural resources, based on the data compiled so far. On the minus side of the balance sheet are the following conclusions:

(1) Conversion and fragmentation of land and natural habitat to accommodate human population growth is a continuing major stress factor on both working landscapes and biodiversity, especially in areas with many special-status species and near the urban fringe. Growth projections indicate increasing impacts in the foothills, the lower to mid-elevations of the Sierra Nevada, and the eastern side of the Central Valley, thus portending particular pressure on oak woodland habitats and perhaps reducing the extent of lands available for timber production;
(2) Several habitats (oak woodlands and coast redwoods) occur predominantly on private lands. Although efforts to improve private land stewardship are ongoing, much of these habitats remain at risk of conversion to residential land uses;
(3) Seven additional species are presumed or possibly extinct since the last report card on the state of U.S. plants and animals was issued in 1997;
(4) More than 224,000 acres of crop and grazing lands were converted to urban land uses between 1988 and 1998. In central and southern California, farmlands and grazing lands represent 30-90% of all lands converted to urban areas. Approximately 90% of the urban lands in Sutter, Yolo, Merced, San Benito, and Madera counties were converted from former farmlands or grazing lands;
(5) Three of the nine top-ranking counties in terms of gross agricultural output (San Diego, Riverside, and Merced) had relatively little land enrolled under the Williamson Act, suggesting that these lands may be at risk of conversion to urban uses.

The data allow us to draw some conclusions on the positive side of the balance sheet as well:

(1) The most recent urban development trends, based on a single modeling approach, seem to indicate that the ratio of “greenfield” to in-fill development is decreasing, i.e., population growth within existing urban areas has increased, and urban expansion onto adjacent lands seems to have slowed in some areas of the state. It remains to be seen, however, if this very recent trend will continue over the long term;
(2) Increased funding to meet a variety of conservation objectives for working landscapes, open space, and biodiversity protection has become available;
(3) Coordinated, collaborative, and stakeholder-driven protection and restoration efforts are increasing throughout the state. Regional planning efforts such as the California Natural Communities Conservation Planning process are being initiated or implemented in several parts of the state. These plans are focusing on some, but not all, of the areas with the highest numbers of special-status species. Other types of conservation planning, such as the CALFED Bay-Delta Program and Coordinated Resource Management Plans are also in progress to meet important conservation needs;
(4) Four of the top five counties with the highest acreage of forestland lost due to development between 1990 and 1998 have between 65% and 91% of their private timberlands enrolled in Timber Production Zones (TPZ). Enrollment in TPZ slows forest conversion;
(5) Three of the top nine counties in terms of gross agricultural productivity had more than 60% of their agricultural lands enrolled under the Williamson Act.

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I. Introduction and Background

The State of California is often associated with three superlatives among its peers in the United States: the highest population, the highest agricultural output, and the highest natural diversity of any state. The first of these superlatives – the state's seemingly unabated population growth and its associated challenges – is putting increasing pressure on the other two. California's burgeoning population – and its famed proclivity for consumption – impacts many readily visible aspects of life in the Golden State, from the air we breathe to the farmlands upon which our food grows. But quite separate from the common usage of the term, both the quality and quantity of life itself – defined in ecological terms – are diminishing in California. Population growth and land use trends in particular are beginning to weigh heavily on the very ecosystem services that human populations rely upon – and which will provide the sustenance for future generations of Californians. Broadly speaking, environmental impacts continue to raise concern among policy-makers and the general public. The California Legacy Project was created, in part, as a response to this concern about the increasing threats to California's working landscapes and biodiversity. The Project's charge is to identify the means through which the State can pursue a comprehensive, strategic approach to preserving, restoring, and sustaining working landscapes, open space, and biological resources.

Many state and federal natural resource agencies in California recognize that there are important problems facing the health and condition of the state's lands and natural resources. However, as in evaluating human health, a broad consensus is needed to properly diagnose these problems and to prescribe appropriate treatments. The Legacy Project is analogous to a forum where the individual health-care providers can come together to compare notes, where staff assembles the individual descriptions of symptoms into a comprehensive and integrated picture of the likely causes of declining health, and jointly with the specialists in their various fields develop a treatment and health maintenance approach. The existing data, as illustrated below, help to diagnose the health of land and natural resources, but additional diagnostic tools (such as data and research), as well as improvements to existing tools, can improve the basis for defining appropriate "prescriptions."

The California Legacy Project has no precedent in the nation. It is a unique statewide effort to integrate conservation assessment and planning among five different conservation objectives: (1) terrestrial biodiversity, (2) aquatic biodiversity and watershed values, (3) working landscapes, (4) recreation lands, and (5) urban open space. Decisions within each of these objectives typically affect the planning and policy choices in the other objectives. For example, decisions about developing conservation easements for high-value croplands near urbanizing areas affect where human population growth can be accommodated. Decisions about setting aside lands for recreation, such as hiking and nature study, or creating open space to improve the quality of life for under-served communities in the urban core may also benefit fish and wildlife. Decisions about linking isolated habitats through wildlife corridors may benefit recreation, ranching, and open-space goals, while limiting or re-directing, such as new housing developments.

The land stewardship and management mandates of individual government departments are often focused on specific program or project areas that have frequently had the

unintended effect of compartmentalizing decisions in isolation from one another. The demand for a holistic, statewide picture of the health and condition of California's landscapes and ecosystems is therefore growing, both within government and in the private conservation community. The Legacy Project is committed to taking on this assessment effort that will integrate the results from separate agency data and assessment programs into a broader perspective. The Project's integrated resource assessments will provide a firmer foundation for evaluating the optimal mix of investments and conservation implementation strategies. It will also be useful for documenting the conservation progress of agency programs according to adaptive management principles.

This first health and condition report builds on the final resource assessment methodology (Resources Agency, 2002b), although full implementation of the methodology will happen incrementally in collaboration with our conservation partners[1]. It will complement the testing and implementation of a final methodology for evaluating conservation options by assembling the data necessary this evaluation. Other Legacy Project reports represent additional foundation blocks for assessing the health and condition of California's conservation resources. These are:

1. Key Data Needs, Evaluation of Existing Data Sets and Identification of Important Data Gaps (California Resources Agency, 2001a);
2. The First Draft Report on the Methodology to Identify State Conservation Priorities (California Resources Agency, 2001b);
3. Legal Mandates Related to the Conservation of Land and Natural Resources (California Resources Agency, 2001c);
4. Report on Conservation Priorities (2002a).

The assessment methodology uses a broadly accepted, science-based framework. It relies on an adaptive management approach, involving an iterative process of planning, doing, evaluating, and adjusting as needed. The approach recognizes the importance of setting goals to ensure that the assessment efficiently targets those areas with the greatest needs. Benchmarks are important for measuring, quantitatively, progress towards those goals. Due to the complexity of natural systems, conceptual models, also known as "situation diagrams," are necessary to depict in simplified form key interactions between species, habitats, ecological functions, physical environment, land use, and human activities, such as commodity production and recreational activities. These models represent organizational tools to insure that critical components influencing conservation considerations are not overlooked. They also serve to highlight those indicators that best represent a variety of multiple, interdependent factors, show sufficient sensitivity to detect meaningful changes, and support management and policy decisions. For further understanding of these concepts, see Appendix A of the Resource Assessment and Trends Methodology (Resources Agency, 2002b).

The methodology recognizes that indicators need to be selected for a variety of interacting landscape and ecosystem attributes: landscape condition, biotic condition (including ecosystems, species, populations, and individual plant or animal conditions), ecological and production land processes, hydrology and geomorphology, chemical and physical characteristics (including water, air, soil, sediment), and natural disturbance

[1] *Conservation partners* include local, state, and federal agencies with natural and commodity resource stewardship mandates, as well as private organizations with conservation missions

regimes. Within each of these attributes, it is important to develop indicators that describe current conditions, important stressors that affect those conditions, and outcome indicators showing management response to conditions considered undesirable or in need of rehabilitation or protection.

Finally, the methodology calls for compiling and analyzing existing data suitable to be aggregated into indicators that reflect the above-mentioned ecosystem and landscape attributes, or developing new data where needed, and reporting the results to show natural resource status and trends. By pulling together disparate sources of statewide data, depicting condition, stressor, and management response indicators on maps, and spatially analyzing and interpreting multiple indicators in combination, we hope to add value to individual and isolated data sets. In combination, these indicators can then be used in evaluating how conservation investments can be applied in a more strategic fashion.

State and federal agencies have already recognized the need for better natural resource assessment and have started to place greater emphasis on this activity in recent years (see the methodology report for descriptions of several of these efforts). The California Legacy Project is designed and funded in such a way that it depends on leveraging and building upon these existing efforts. Therefore, partnerships with other assessment programs are essential to provide meaningful products in the near-term. This collaboration is also important over the long-term to provide a more complete statewide picture of resource status and trends. Such collaboration is fundamental to the Project's methodology to develop goals, benchmarks, and indicators, to integrate data and to interpret analytical results.

These partnerships need to benefit both the Legacy Project and the departments involved. Existing assessment programs usually operate with limited funds and, by necessity, focus on issues of greatest importance to individual agencies or programs. Any significant request for modifying their current direction – for example to focus on larger geographic areas or to address different assessment questions – is likely to require additional funding to ensure that it does not distract from current mandates and other pressing issues. Modifying some existing assessment approaches could improve the Legacy Project's ability to answer broader questions in a more robust manner. Increasing and leveraging additional funding from a variety of sources as part of such modification would benefit agencies by expanding their current efforts and placing them in a strategic statewide context.

Implementation of the methodology, depending as much as it does on these partnerships, requires time for several important steps, such as:

- convening policy makers and specialists;
- understanding their existing assessment strategies;
- comparing their strategies to the proposed Legacy Project methodology;
- identifying common goals to work on;
- selecting appropriate indicators;
- compiling, analyzing, and interpreting data;
- sharing this information with all stakeholders to facilitate understanding and participation in investment choices.

Other important steps, which require additional time, include developing both benchmarks and conceptual models as well as identifying and filling major data gaps.

The following sections of the report show specific examples of our diagnostic approach with some preliminary conclusions about the "health and condition" of biodiversity and working landscapes.

II. Examples of Status and Trend Indicators and Progress in Data Integration

This section of the report provides examples of how the methodology, when fully operational, can produce maps of natural resource status and trends and how resource health and condition can be analyzed in the context of making conservation investments throughout the state. These examples illustrate three of the five Legacy Project conservation objectives: *terrestrial and aquatic biodiversity* and *working landscapes*. Data compilation, integration, and analysis on rural recreation and urban open space "health and conditions" will be included in future assessments. Within each of the three example conservation objectives, the report provides two sets of examples, each showing data that could be used as indicators for condition, stressors, and management response.[2] Some indicators serve multiple purposes. Maps that can be used to illustrate condition, stressor, or management response indicators will be shown in the section where they are first discussed and referred to in subsequent sections.

Biodiversity examples focus on land cover/vegetation and sensitive species. These two topics are among the most important for conservation planning and for which a considerable amount of data exists. Working landscape examples are forestlands and agricultural croplands. We will address rangeland "health and condition" in future reports. These two topics represent some of the highest priorities for conserving working landscapes in California. Numerous data exist for these two topics as well. For forestlands, the California Department of Forestry and Fire Protection (CDF) will be releasing an assessment of forest and rangelands in the fall of 2002. The forthcoming report, entitled *The Changing California – Forest and Range 2002 Assessment,* will provide a more in-depth analysis of a wide variety of indicators of natural, social, and economic capital than is contained in this report.

Much of what we know about resource health and condition has been collected with specific issue or project-focused questions in mind, rather than being designed to answer broad questions related to strategic allocation of conservation investments throughout the state. The most comprehensive and detailed data sets, which can provide the best answers to conservation questions, are of limited geographical scope, leaving substantial geographic gaps in statewide coverage. The Legacy Project has managed to develop the working relationships with our conservation partners to provide

[2] Although the methodology calls for both programmatic and environmental "outcome" indicators, such indicators will need substantial discussion with our state agency partners to adequately reflect the progress of conservation activities. Given the current lack of statewide goals and benchmarks in the interim, this report uses the more objective term "management response indicators" to show ways those agencies have responded to conservation needs.

some reasonable approximations of the distribution of natural resources and the risks that face them within the context of data limitations.

Statewide databases especially need to be qualified when used to make statements about natural resource status and trends, given their coarser nature. For example, the California Natural Diversity Data Base (CNDDB), used in the example below, is the most complete inventory of sensitive species and habitats, with records representing much of the state. However, the data are often collected to answer the question "Does this particular species occur in this particular location?" - an important question for project-level work. Answering this type of question typically involves a focused field-search for a specific species at a specific site. The more difficult statewide questions, such as "Where in the state does this species exist?" or "Where are the areas with the greatest concentrations of sensitive species?" and "Are population levels increasing or decreasing?" are more important for statewide assessments, because they provide more definitive and comprehensive answers about conservation needs across the state. They also require comprehensive, and thus expensive, surveys of all potential habitats statewide for either a particular species or set of species. Such comprehensive surveys are rare and usually available only for small geographic areas.

The Legacy Project, as well as other assessment programs, is making headway in integrating scattered datasets into statewide or, in the case of species, rangewide datasets for California. For example, the Project will release a new, updated public and conservation lands data set in late fall of 2002, integrating ownership data from major state and federal agencies. Future versions of this data set will include more complete coverage of local and private conservation lands. A second example is the vegetation mapping standards whose development is being facilitated by the Legacy Project through an interagency vegetation mapping and classification group. These standards will help integrate and improve existing and future vegetation mapping efforts, with the long-term goal of cost sharing the development and maintenance of a detailed statewide vegetation data set.

Important gaps in existing data are an important issue to keep in mind. For example, few data sets provide time-series information, allowing one to compare today's conditions with past conditions. The Legacy Project's 2001 data survey report (Resources Agency, 2001a) highlights several of these important data gaps, setting the stage for current and planned data development activities. Participants in that survey felt limited, though, due to the lack of specific management questions and goals needed to define data needs. The Legacy Project has been instrumental in starting a dialogue among all its conservation partners and bringing together environmental managers and scientists to more clearly identify the key questions relevant to conservation decisions, so that data needs can be clearly defined. Given current funding for assessment, it is likely that additional funds will be needed to fill other priority data gaps, as well as to provide professional staff to both design effective data collection and to interpret the results.

As mentioned above, regional and local datasets can be more complete and of higher quality than statewide databases for their limited areas of coverage. These data sets are usually stored in scattered locations, and small audiences only know of their existence. Their data quality varies considerably, with some data sets being more useful than others. To discover important regional and local data sets, the Legacy Project is

funding a statewide survey and evaluation of those data sets that intersect with the Project's goals.

The results of this survey will augment the California Environmental Resource Evaluation System's (CERES) Environmental Information Catalog.

Finding these data sets is only part of the issue. These focused data sets meet customized needs, with data collected and stored in different ways (such as varying resolution, accuracy, and data structure). This complicates integration into a statewide perspective. Despite these issues, some of the map examples shown in this report demonstrate that it is indeed possible to merge data sets, each managed and stored in different ways. Until standardized data exchange mechanisms are developed and implemented, however, data integration and subsequent production of maps showing condition, stressor, and management response indicators will remain a time-consuming effort.

Yet another issue is interpreting the data to make robust statements about the actual status and trends of resources, their interactions with each other, the influences of different stressors on those resources, and the effectiveness and appropriate balance of management response to those stressors. As above, more detailed and higher quality data increase the certainty that one's conclusions are sound and accurate at a pre-determined level of precision.

Conceptual models are also important for understanding the interactions, such as cause and effect, among resources, stressors, and outcomes. These models can help guide appropriate analytical techniques to answer a typical question such as "How does this specific stressor impact this specific resource?" Such models, however, are only as reliable and specific as the underlying data and understanding of complex systems. For this reason, in parallel with developing conceptual models where feasible, the Legacy Project will continue to place a strong emphasis on data improvement.

For current decision-making needs, existing data, such as the examples provided in this report, can be used to make some general inferences on a statewide level. However, conclusions and recommendations for management actions will still need to be qualified until better data and models are developed.

A. Terrestrial and Aquatic Biodiversity

Biodiversity is often considered in terms of ecosystems, species, and genes. Each can be assessed in terms of biological composition and structure as well as function. Assessment programs in state and federal agencies have invested considerable funds and staff time on ecosystems and species, with a primary focus on their composition. For ecosystems, this focus on composition translates to describing the distribution and abundance of vegetation and habitat types across the landscape. For species, current efforts focus on the distribution and, for some species, the abundance of plants and animals throughout their range in California. Special emphasis is placed upon special-status species (such as endangered species) and game species. This emphasis on habitat and special-status species, reflecting the conservation priorities of state agencies, guides the following choice of biodiversity examples.

Examples of Potential Ecosystem Condition Indicators

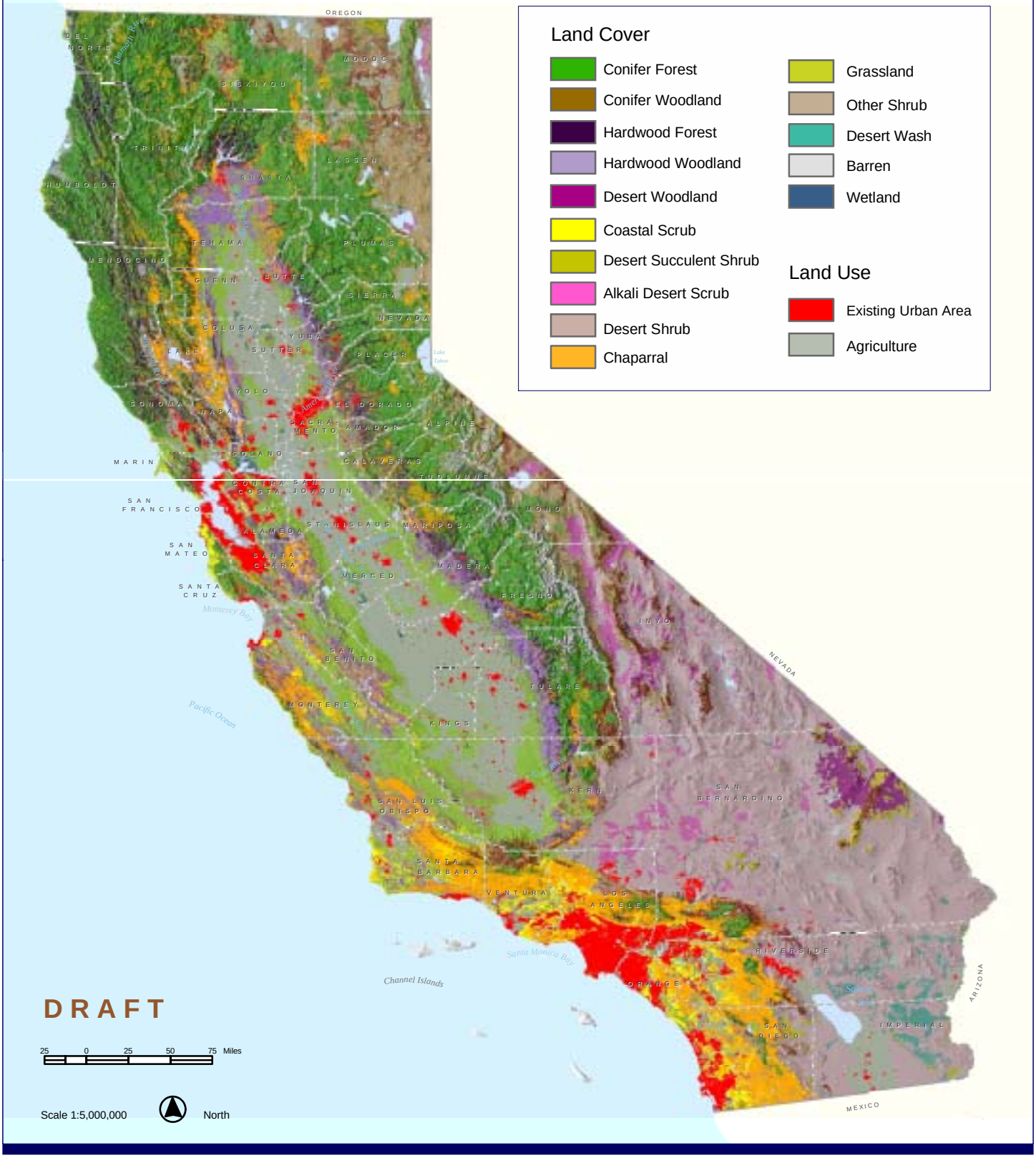
Distribution of Habitat Types

The distribution of habitat types across the state is used as an example indicator for habitat condition. Habitat condition could be assessed in other ways, for example, in terms of each habitat's resilience to disease, fire, invasive species, and/or drought, the habitat's sensitivity to the effects of human disturbance (roads, soil erosion, structures, etc.), the abundance and distribution of unusual or biologically rare vegetation types (rare soils, vernal pools, rare plant communities, etc.). Condition can also be described in terms of ecological processes, such as natural fire regimes or natural rates of insect-induced mortality. Efforts to model, prioritize, and design habitat linkages, for example, are currently being co-funded by the Legacy Project. We intend to place future data and analysis efforts on these or other indicators of habitat condition after completing an important step described in the assessment methodology (Resources Agency 2002a) – the selection of a complete list of indicators relevant for statewide conservation decisions. More discussion with agency partners will help identify which mix of the potential indicators of habitat and ecosystem condition listed above is appropriate and required for more informed investment decisions.

The Land Cover and Habitats map (Figure 1) aggregates numerous categories of the most detailed existing statewide coverage of land cover, compiled by CDF. The data set behind this map uses 55 different types to classify land cover, but these have been simplified into a set of 17 different habitat and land cover types to display in this report, since the size of the map restricts the level of detail that can be shown. Understanding the distribution of habitat types is valuable for predicting the potential distribution of plants and animals where occurrence information is currently lacking.

As shown on the map, extensive conifer forests cover the Sierra Nevada and northwestern parts of the state. Hardwood forests and woodlands rim the edge of the Central Valley and are abundant in the central Coast Ranges. Shrub lands predominate in the northeastern part of the state and in the central and south coast regions. Shrub lands in the northeastern part are primarily sagebrush and other Great Basin shrub species, contrasting to the chaparral shrub lands of the southern regions. Shrub lands, such as creosote scrub (mapped as part of desert shrubs) also dominate in the Mojave and Colorado Deserts.

Much of the pre-settlement grasslands and other habitats of the Central Valley have been replaced by agriculture or urban landscapes. Urban landscapes have also replaced considerable habitat in the San Francisco Bay Area and the metropolitan south coast. See discussion on stressors below for more information on habitat conversion.



Land cover data created by the California Department of Forestry and Fire Protection. Last updated 2002. Existing urban areas based on Department of Conservation Farmland Mapping and Monitoring Program data and John Landis, University of California at Berkeley.

This is a draft map only and is not intended for planning purposes.
Publication Date: December 5, 2002

The data used for this map represent a composite of the best available land cover data sets in California and come from several mapping efforts. These include the joint effort by CDF and the U.S. Forest Service (all of the state except Central Valley and deserts), the California Department of Fish and Game's (CDFG) Wetlands and Riparian GIS database, the University of California at Santa Barbara's (UCSB) California Gap Analysis Program, the California Department of Conservation's (CDOC) Farmland Mapping Program, and several other regional vegetation-mapping efforts.

The composite data are suitable for moderate-scale (1:60,000 or greater) land use and land management planning, such as for fire and timber management, recreational trail development, etc. and uses a minimum mapping unit of 2.5 acres. Conservation planning at finer scales (1:24,000) is important to many resource agencies, which need more detailed mapping units, improved spatial accuracy, and more detailed vegetation classification. More detailed vegetation classification is valuable for detecting habitats, such as vernal pools, or limestone and serpentine areas that are important for plants and less mobile animals.

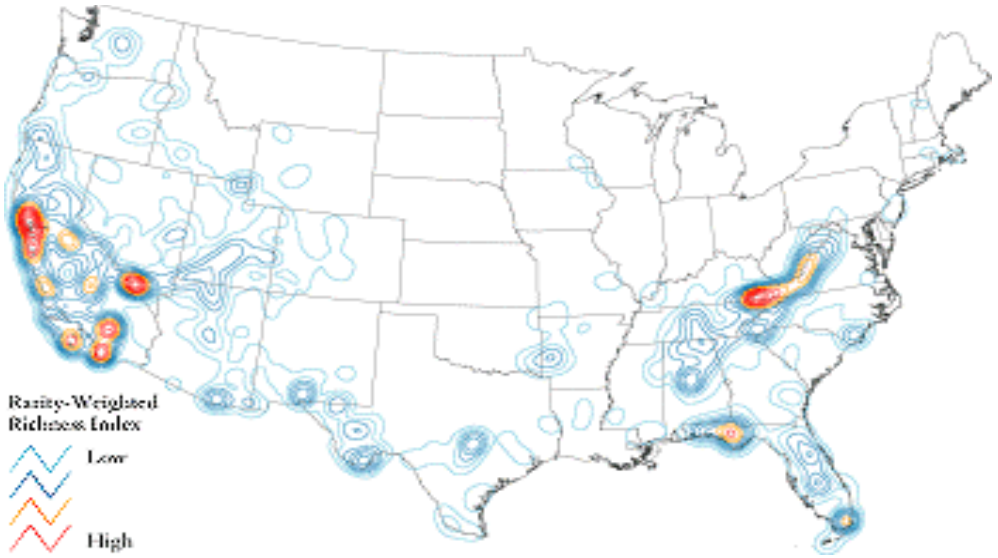
To meet these conservation planning needs, the Legacy Project has been facilitating an interagency effort to eventually create a more detailed and accurate statewide vegetation data layer. This could be a well-funded, statewide interagency cost-shared program. Or it could simply be a phased effort over time in which existing mapping efforts are modified, and future mapping efforts are designed, to conform to consistent mapping and classification standards. Either way, both strategies need a set of data standards to maintain data quality. Recognizing this, the Project's interagency effort has focused its initial efforts on the development of such standards. During the past year, this group has made considerable progress at the technical level, thus paving the way for eventually creating the vegetation and habitat data needed for conservation planning at various levels of detail.

Richness of Special-status Species

Special-status species include those species either listed, proposed for listing, or candidates under the state or federal endangered species acts, as well as other species considered to be sensitive, declining, or biologically rare. The rarity-weighted richness index and distribution of special – status plants and animals are a second example of the range of potential condition indicators to assess biodiversity.

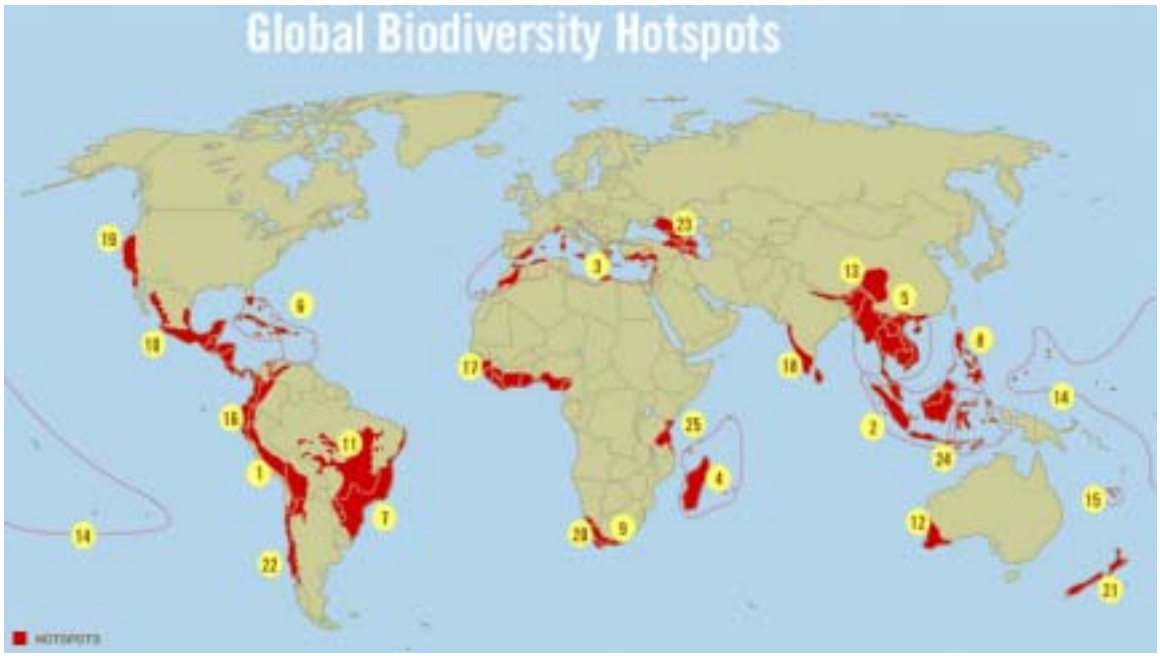
On a national scale, California far outweighs other states in the continental U.S. on the nationwide "Rarity-weighted Richness Index" developed by the private conservation organization NatureServe (Stein, *et. al.*, 2000 – see Figure 2). California ranks first among all states in plant and mammal species diversity. It has 2,034 special-status plant taxa – more than any other state. This list includes both plants that are naturally low in numbers due to restricted habitats and plants that have become rare due to human activities (http://www.oup-usa.org/sc/0195125193/index2.html).

Figure 2 – National Rarity – Weighted Richness Index (from Stein et al. 2000)



The density of special-status species in California needs to be put in a national and global perspective because of California's unique status as one of the world's "hotspots" of biodiversity.

Figure 3 - Top 25 World Biodiversity Hotspots (from Myers, et al. 2000)



A global summary of biodiversity by *Conservation International* identified 25 global "hotspots," one of which is California (see Figure 3). The key criteria for determining a hotspot are endemism (the presence of species found nowhere else) and degree of threat. Plant endemism is the primary criterion for hotspots status. The degree of threat is measured in terms of habitat loss. Hotspots have lost at least 70% of their original natural vegetation.

Focusing within California, many of the species found in the state are unique to California and occur nowhere else in the world. Thirty-one percent of the state's plant species (and 62 % of plant subspecies and varieties), 38% of the freshwater fish species, and 29% of the amphibian species occur only within California (Jones and Stokes Associates 1987).

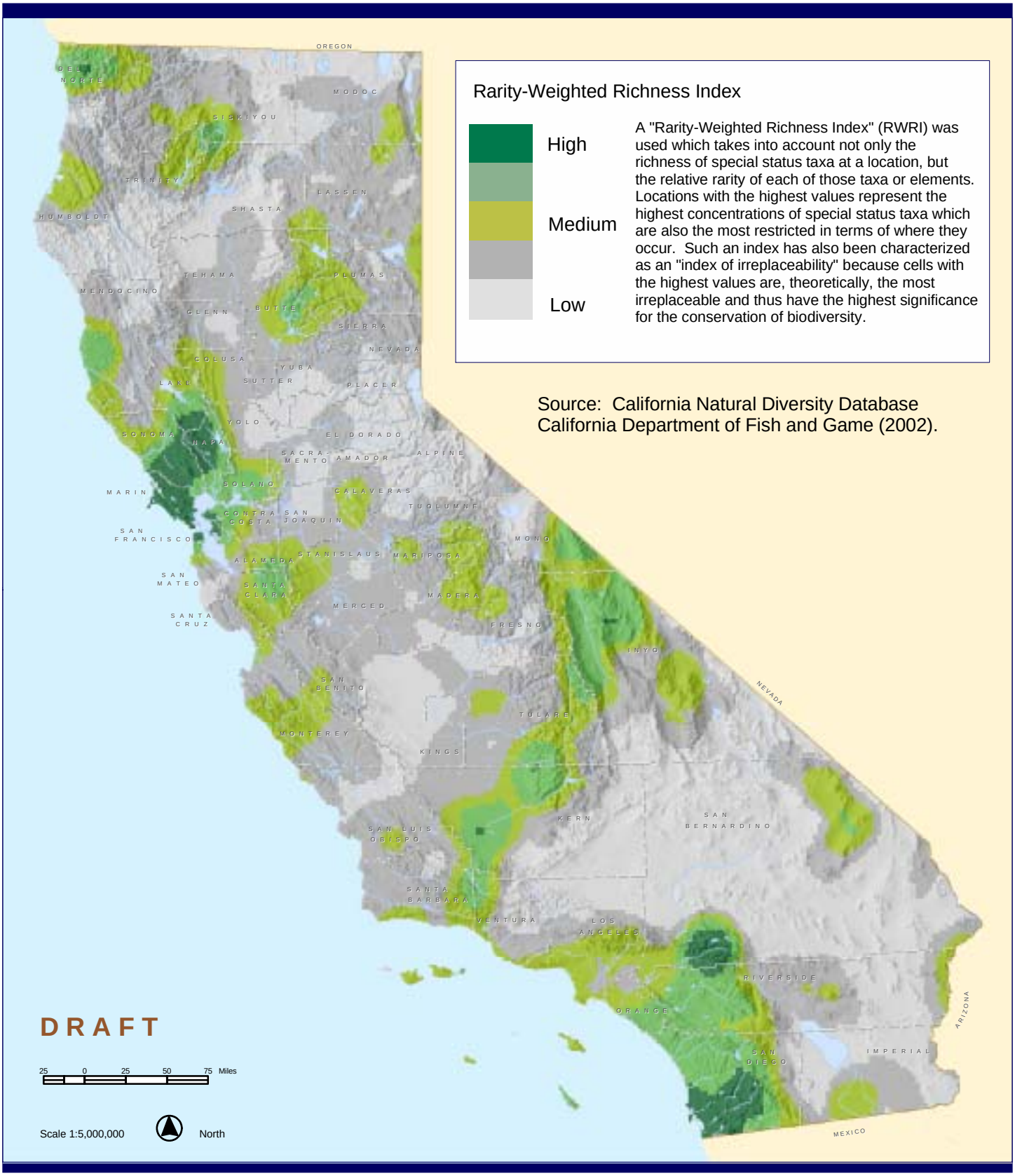
The state is third among all states (after Hawaii and Alabama) in terms of species extinctions (Stein, 2002). Of the 53 presumed or possibly extinct species in the state, about half are plants. California also ranks third in the nation in mammal and bird species at risk, and fifth in reptile species. Within the last five years, since The Nature Conservancy issued its previous report card on the state of U.S. plants and animals (The Nature Conservancy, 1997), seven more California species have been added to the list of presumed or possibly extinct species in California (Stein, 2002).

This report uses the distribution of special-status species to illustrate how richness of these species can serve as an indicator of ecosystem condition. This indicator is equivalent to an aggregate measure of many individual data points summarized from species observations into a "rarity-weighted richness index" (RWRI), also often referred to as "index of irreplaceability." Other indicators that could be used to describe the condition of special-status species include, for example, descriptions of population levels and trends, reproductive rates, and life history needs. Data of this sort are expensive to acquire and are currently only available for few species over limited areas. Legacy staff will work collaboratively with agency biologists to identify the most suitable condition indicators for these species.

Two separate maps (Figure 4 for plants and Figure 5 for animals) depict the relative density of special-status species within the state. These maps represent high-priority special status plants and animals, including fish and invertebrates, and were created using locational data from the California Natural Diversity Database (CNDDB). The "rarity-weighted richness index" was used as the measure of rarity, the same approach as that used by the Association for Biodiversity Information, now known as Nature Serve - shown above in Figure 2 from all 50 states (Stein et al. 2000).

The RWRI takes into account not only the richness of special status taxa (species and subspecies) within a map cell but also the relative rarity of each of those taxa. Plants and animals with the highest weights are those that are the most limited in distribution (fewest number of locations). The weights are then summed for each of the cells. Cells with the highest values represent the highest concentrations of special-status taxa that are also the most restricted in terms of where they occur.

This index has also been characterized as an "index of irreplaceability" because cells with the highest values are, theoretically, the most irreplaceable and thus have the highest significance for the conservation of biodiversity. Use of the index for conservation rests on several assumptions, one being that the entire distribution of any given special-status element in California is known. For any given species or subspecies an analysis of irreplaceability might also include such factors as total population size and reproductive success - data only available for a few species in selected areas of the state. Nonetheless, the RWRI is strongly related to the index of irreplaceability, and thus the results of this analysis are presented here.



The California Natural Diversity Database (CNDDB) is managed by the California Department of Fish and Game. The CNDDB is continually being improved and is not comprehensive for all species locations.

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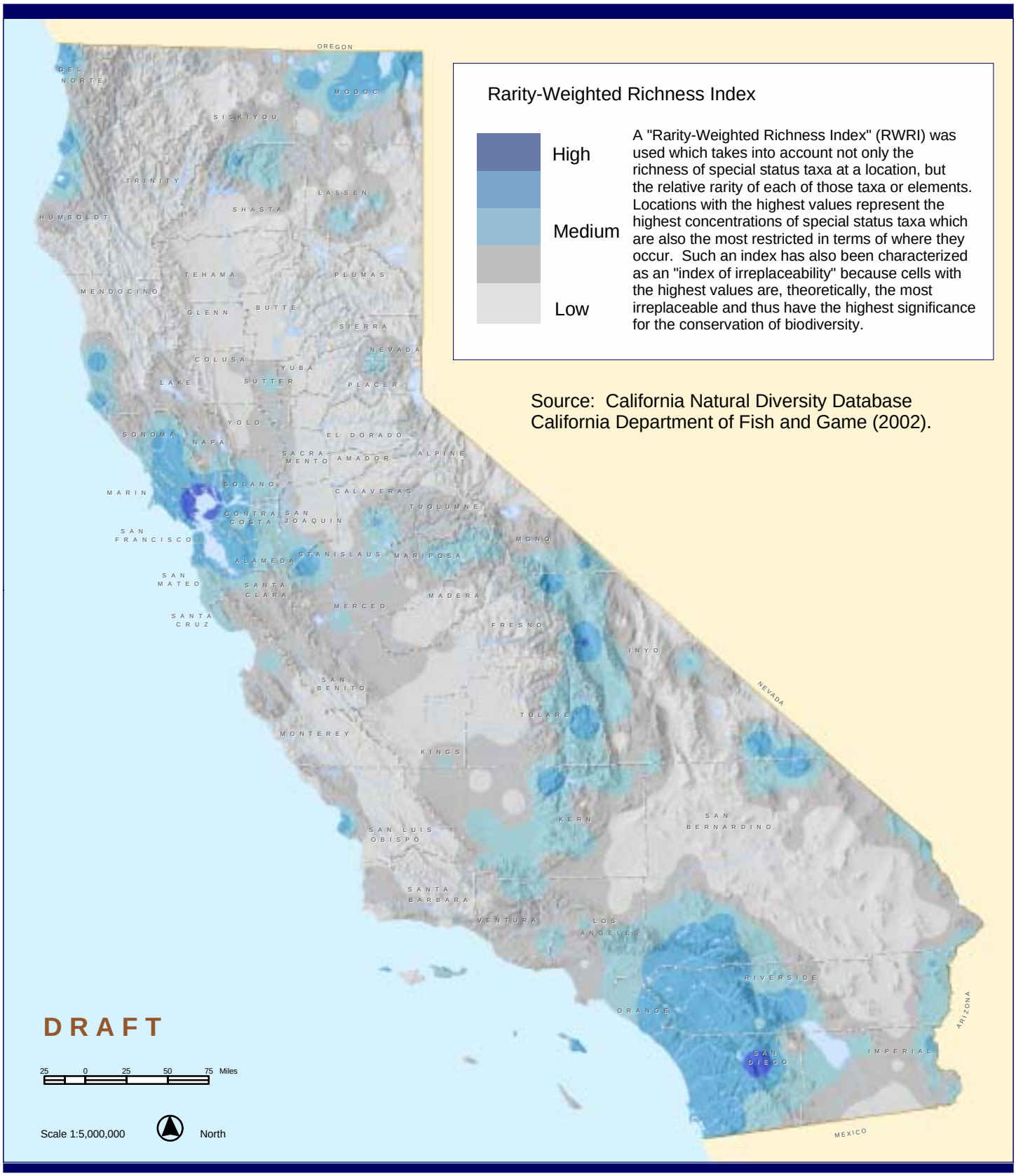

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The highest richness index values of special-status plants occur in the San Francisco Bay Area, the San Bernardino Mountains, southwestern San Diego County, and several scattered locations in Kern, Inyo, and Del Norte counties. The highest index values of special-status animals also occur in the San Francisco Bay area, the south coast region, and Inyo County. Although large areas of the state have relatively low richness values for both plants and animals, special-status species have been recorded from almost every part of the state.

Although CNDDB is the most comprehensive special-status inventory in the state (containing approximately 40,000 records for 460 animal and over 1300 plant taxa), it still needs continued improvement to fully meet the needs of conservation planners. It does not represent a comprehensive picture of all special-status species in all locations. Data are received by the program typically on a voluntary basis, usually from field researchers looking in specific areas for specific species. As a result, data records are usually most abundant in areas of rapid land use change (surveys prompted by environmental review processes) or near universities (surveys prompted by professors and students) where biologists have done field surveys and submitted data to the California Department of Fish and Game (CDFG). Thus, this *ad-hoc* sampling design for data collection skews the data and limits the inferences one can make, such as describing trends in species extirpations. Each new land use planning effort involving potential biological impacts generates new data that are used to continually update CNDDB. As a result, this is also a highly dynamic database, requiring subscribers to obtain updated data sets at least every six months.

A soon-to-be-released report by CDFG, entitled *The Atlas of Biodiversity of California*, draws on CNDDB and other CDFG biological databases. It will provide more detailed information on specific habitats and species from throughout the state, pressures on biodiversity, and steps currently taken to sustain biodiversity. The results from this report will be integrated into future Legacy Project assessment reports.

Examples of Potential Stressor Indicators

California's habitats and special-status species are stressed by many factors, including loss and degradation of habitat, habitat fragmentation, invasions by introduced species, simplified hydrologic processes and functions, water development, pollution impacts from local, regional, and global sources (including compounds that contribute to global climate change), increased human disturbance, and epidemic plant diseases. Identification of the types of stressors and the potential cumulative risks these stressors pose is an important priority for the Legacy Project to facilitate decisions on stress and risk prevention, restoration, protection, and maintenance investments for valued habitats.

Much of California's terrestrial biodiversity has been reduced primarily by conversion of vast areas to housing, transportation, agricultural, and extractive uses, and to a lesser extent by invasions by exotic species and pollution impacts. As Table 1 illustrates, the settlement of California, first by Europeans and then by other immigrant populations, has dramatically reduced the extent of many habitats, with losses for some habitats ranging from 70% to 99.9% (Noss and Peters, 1995). For example, almost 100% of needlegrass steppes, 99% of native grasslands, 91% of wetlands, 89% of riparian areas, and 80% of

Southern California coastal sage scrub habitat have disappeared (Noss and Peters, 1995).

Table 1: Loss of Selected Habitat Types

Habitat and Vegetation Type	Estimated Percentage of Original Habitat Lost
Needlegrass Steppes	99.9
Native Grasslands	99
Wetlands	91
Riparian Areas	89
Coastal Sage Scrub	80

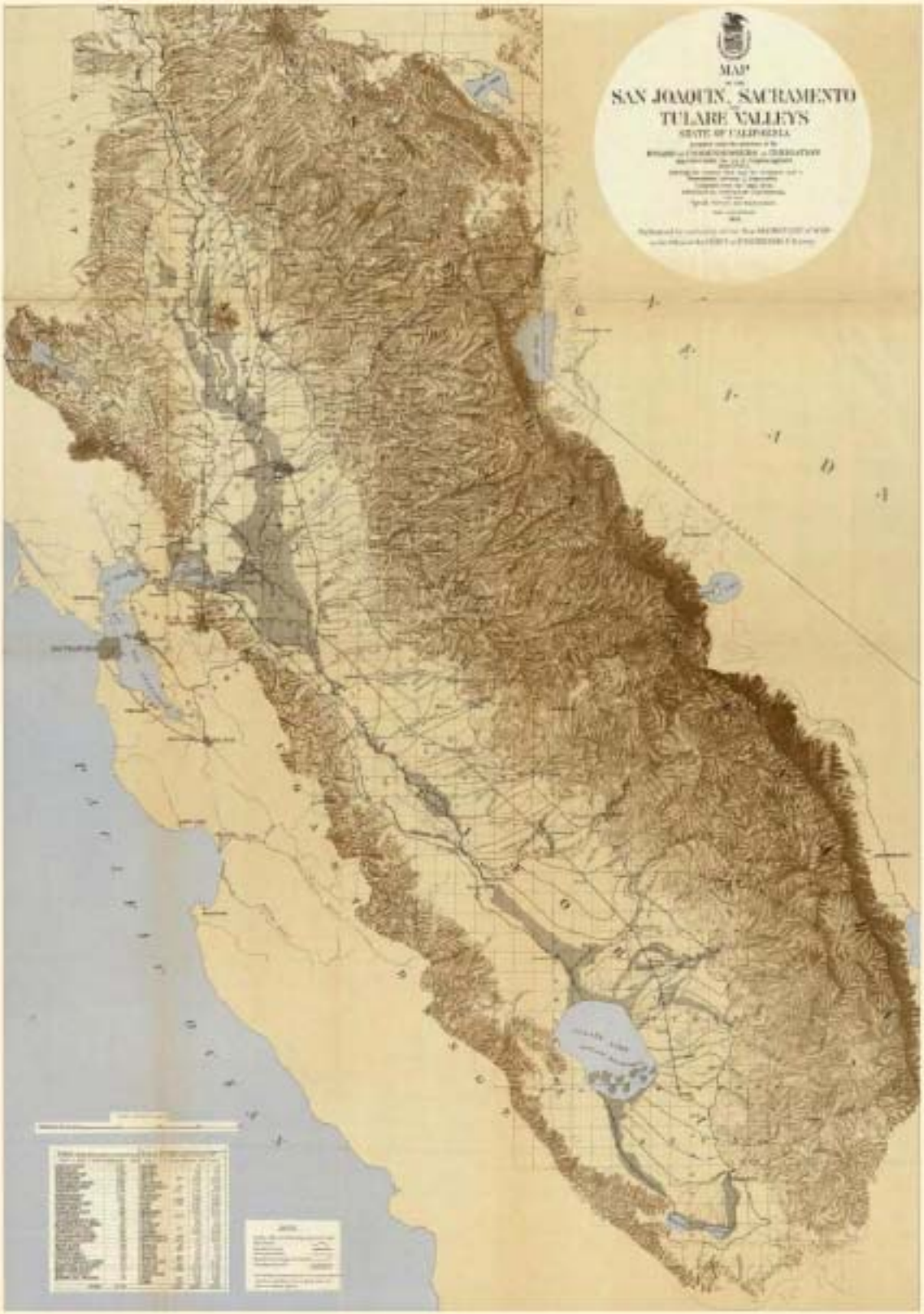
Aquatic biodiversity has suffered similarly, if not more so than terrestrial biodiversity since the arrival of early Europeans. Although California has lower diversity of species dependent on aquatic habitats than other states (Alabama and North Carolina rank first in fish and amphibian species diversity, respectively), it ranks first in amphibian species at risk and fifth in at-risk fish species (Stein, 2002). Furthermore, a significant portion of at-risk bird species in California is dependent on riparian habitat corridors (RHJVP, 2000).

In addition to habitat conversion to human land uses, dewatering, water diversions, and large-scale modification of watershed and stream processes have also impacted aquatic biodiversity. Few other states in the nation have seen more profound impacts on aquatic ecosystems than California due to changes in the timing and amount of stream flow (Reisner, 1986). The vast majority of rivers and streams in California have been dammed and diverted in the most extensive “re-plumbing” scheme in the world to date. Figure 6 is a depiction of the Central Valley in the late 19th Century, prior to the large-scale conversion of natural landscapes to agricultural uses and associated alterations of the natural drainage system. Extensive riparian corridors and floodplain marshes covered large areas along the river channels and in the Sacramento-San Joaquin Delta.

One of the most dramatic examples of aquatic habitat alteration by means of water diversions and draining of wetlands is the demise of Tulare Lake which formerly covered most of the land that later became Kings County. Tulare Lake was said to have been the largest in the western United States (Figure 6). An 1892 description by Thomas H. Thompson, a historian of the city of Tulare, said: "The area of the lake at highest water (220 feet above sea level) was 760 square miles (excerpted from: "Kings County Historical Review", Bentley, 1994). Tulare Lake was one of the greatest expanses of wetlands along the Pacific Flyway. Today, only about 4% of the historical extent of marshes, sloughs, and lakes in the Central Valley have survived (Thelander and Crabtree, 1994). As a result, the number of waterfowl that once navigated the Pacific Flyway on their annual migration has been reduced from an estimated 60 million birds to approximately three million.

Two key stress factors impacting habitat and species are the extent of habitat conversion and road distribution/density. Data are available for much of the state showing these two factors, and they are used below to illustrate potential stressor indicators.

Central Valley (1873)



Source: David Rumsey Map Collection, www.davidrumsey.com

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Figure 6

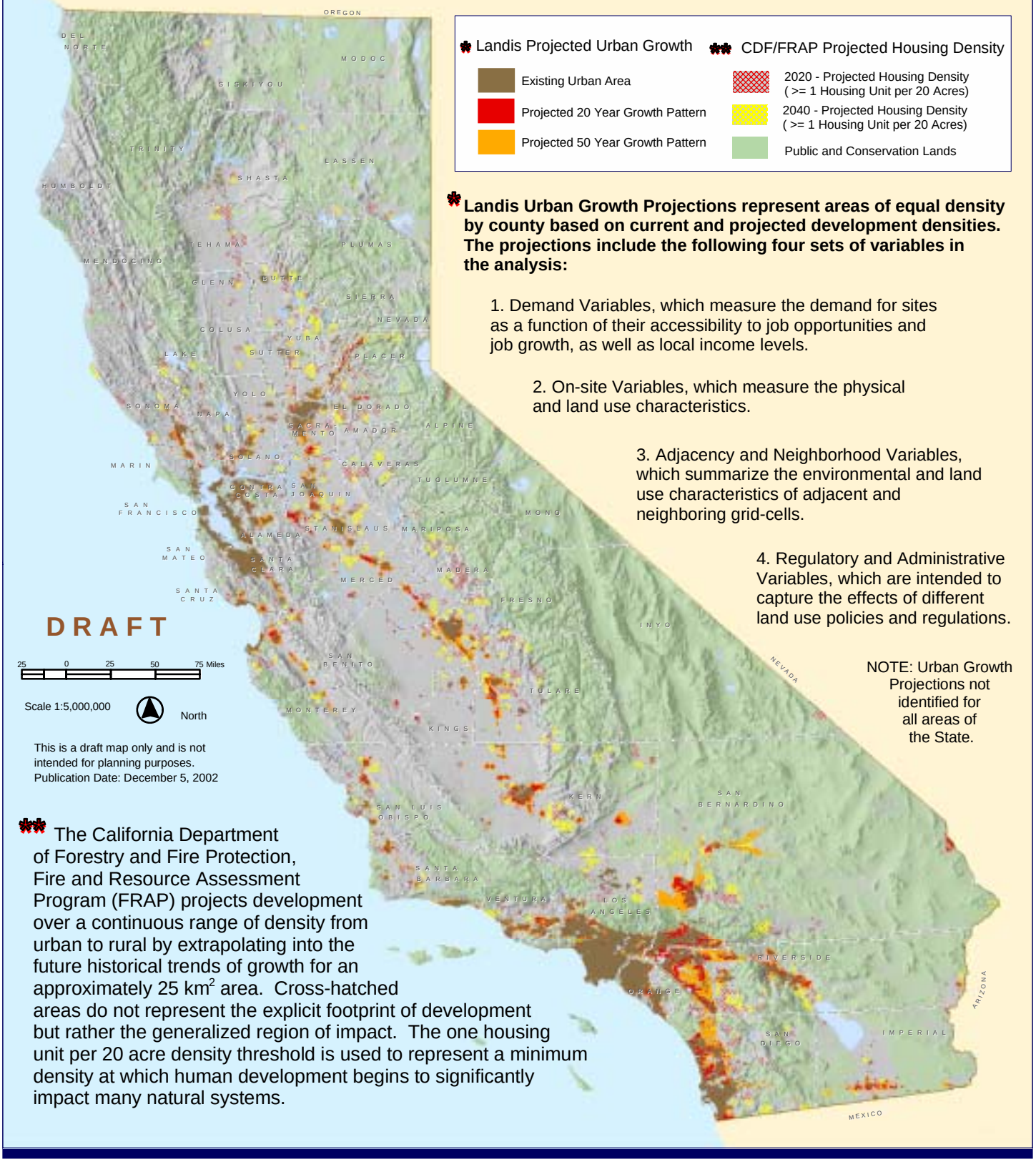
Projected Urban Growth and Housing Density

Probably the most important stress for most species in California has been the conversion of natural habitat into croplands and urban areas. By 1900, nearly 15 million acres of California's original wetlands, grassland, riparian and valley oak forests, and other habitats were converted to agriculture. Between 1945 and 1980, nearly 5 million acres of habitat were converted to urban landscapes, affecting grasslands, oak woodlands, and coastal scrub (Jones and Stokes Associates, 1992), albeit at different rates. In some cases, displacement has been almost complete, as with native grasslands and freshwater marshes, while other habitat types have experienced lower rates of conversion.

Such habitat conversion is expected to continue, given current growth projections. The California Urban and Biodiversity Analysis (CURBA) model (Landis et al., 1998), and subsequent updates developed by John Landis and his team at the University of California at Berkeley, show the expected spatial distribution of this growth based on Department of Finance population growth projections for California. Figure 7 is a statewide view, and Figure 8 is a closer view showing those regions where urban growth projections have been completed. Details of how these projections were derived can be found in Landis and Reilly (2002). Urban growth projections for the upper Sacramento Valley, the North Coast, and the northern Sierra and Cascade Region will be added to future map updates.

The Fire and Resource Assessment Program (FRAP) of California uses a different algorithm than the CURBA model. It allocates all people into all census blocks or larger units, whether or not they fall in the urban or non-urban category, while the CURBA model places 100% of the population into urban blocks. The California Department of Forestry modeling approach is also based on Department of Finance population growth projections for the state. It forecasts development over a continuous range of density from urban to rural by extrapolating into the future historical trends of growth for an area approximately 25 square kilometers in size based on their share of the 1980-1990 housing growth. The crosshatched areas in Figures 7 and 8 do not represent the explicit footprint of development but rather the generalized region of impact. The one housing unit per 20 acre threshold is used to represent a minimum density at which human development begins to significantly impact many natural systems. The CDF technique has the advantage of providing a consistent scenario for the whole state that can be analyzed at any scale from a ten square mile area, a county, a region, to the entire state.

A comparison of Figure 1 (Land Cover) with Figure 7 (Projected Urban Growth and Housing Density) shows that projected urbanization is likely to affect Central Valley habitats (grasslands, wetlands), foothills (hardwoods, chaparral), lower to mid-elevations of the Sierra Nevada (conifer forests), south coast (coastal scrub, chaparral), and areas of the western Mojave Desert (creosote shrub and alkali desert scrub). More in-depth analysis can provide quantitative information about which habitats are most at risk of urbanization. These projections indicate that certain habitats, such as oak woodland, will be under particular threat of being further impacted. Recognizing this threat may facilitate pro-active management responses targeted at preserving and maintaining these types of habitats prior to experiencing large financial and institutional obstacles to their conservation.



Landis Urban Growth Projections represent areas of equal density by county based on current and projected development densities. The projections include the following four sets of variables in the analysis:

1. Demand Variables, which measure the demand for sites as a function of their accessibility to job opportunities and job growth, as well as local income levels.

2. On-site Variables, which measure the physical and land use characteristics.

3. Adjacency and Neighborhood Variables, which summarize the environmental and land use characteristics of adjacent and neighboring grid-cells.

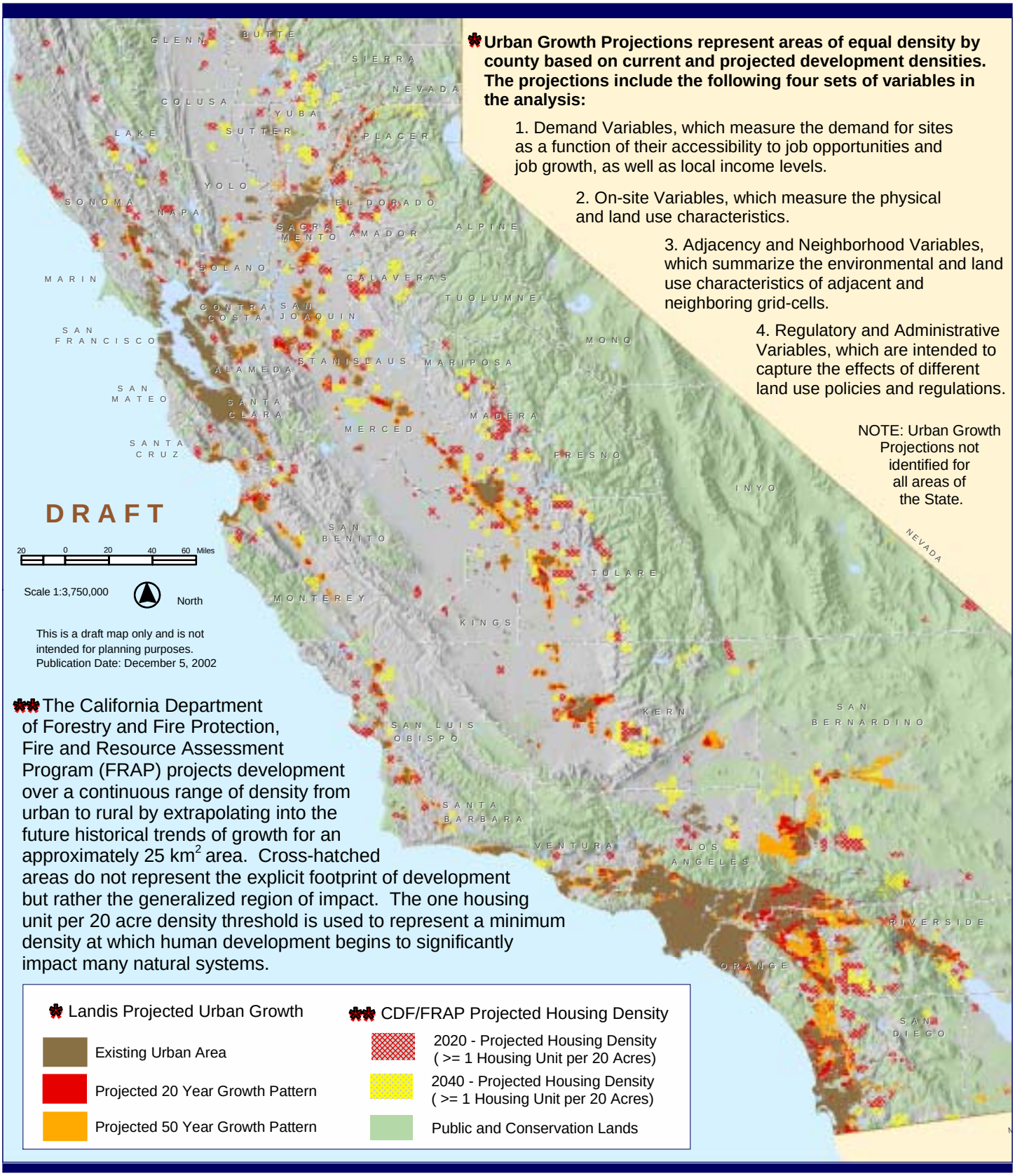
4. Regulatory and Administrative Variables, which are intended to capture the effects of different land use policies and regulations.

NOTE: Urban Growth Projections not identified for all areas of the State.

The California Department of Forestry and Fire Protection, Fire and Resource Assessment Program (FRAP) projects development over a continuous range of density from urban to rural by extrapolating into the future historical trends of growth for an approximately 25 km^2 area. Cross-hatched areas do not represent the explicit footprint of development but rather the generalized region of impact. The one housing unit per 20 acre density threshold is used to represent a minimum density at which human development begins to significantly impact many natural systems.

Projected Housing Density Increases provided by the California Department of Forestry and Fire Protection, Fire and Resource Assessment Program (FRAP).
For more information please see http://frap.cdf.ca.gov/data/frapgisdata/select.asp

Projected Urban Growth data provided by John Landis, University of California at Berkeley. Last Updated 2002. County population projections for the year 2020 and 2040 were obtained from the California Department of Finance, Population Research Unit. Existing urban areas based on Department of Conservation Farmland Mapping and Monitoring Program (FMMP) data.



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Landis Projected Urban Growth	CDF/FRAP Projected Housing Density
Existing Urban Area	2020 - Projected Housing Density (>= 1 Housing Unit per 20 Acres)
Projected 20 Year Growth Pattern	2040 - Projected Housing Density (>= 1 Housing Unit per 20 Acres)
Projected 50 Year Growth Pattern	Public and Conservation Lands

Projected Housing Density provided by the California Department of Forestry and Fire Protection, Fire and Resource Assessment Program (FRAP).
For more information please see http://frap.cdf.ca.gov/data/frapgisdata/select.asp

Projected Urban Growth data provided by John Landis, University of California at Berkeley. Last Updated 2002. County population projections for the year 2020 and 2040 were obtained from the California Department of Finance, Population Research Unit. Existing urban areas based on Department of Conservation Farmland Mapping and Monitoring Program (FMMP) data.

Comparing the projections with the special-status species maps shows that areas with high irreplaceability index values overlap in areas with existing urban development. This is not surprising, since data often come from surveys associated with planned additional development near or in existing urban areas. Future urban growth is expected in these same areas, increasing stress on those areas with many rare species. More analysis is needed to document where species occur and which species are at greatest risk in areas projected for additional urban growth. Some areas with high index values (Del Norte County, southwestern San Joaquin Valley, Modoc County, East Mojave, and Owens Valley area) are not likely to experience significant urban growth, although they may face other types of stress (such as certain agricultural land management practices, water diversions, disruption of natural hillslope and watershed processes, and other factors). Additional analysis is needed to show the nature and extent of these other stressors on special-status species.

The most recent urban growth projections based on the updated CURBA model, on the other hand, show a somewhat more encouraging trend in urban infill development. Compared to prior results, projected urban expansion areas depicted in Figures 7 and 8 are significantly smaller. Based on very recent trends, Landis and his team expect urban densities and infill rates (the share of development accommodated within already-developed areas) to increase, thereby reducing the demand for undeveloped "greenfield" lands. The extent of this effect is likely to vary markedly by region and county. For example, the Los Angeles metropolitan area has recently experienced more extensive infill development than the San Francisco Bay Area, where housing for the increasing population tends to fall more into the "sprawl" development category (Reilly, personal communication).

More analytical results will be provided in CDF's Forest and Range 2002 Assessment report. A general statewide conclusion from that report, however, is that, up until now, agricultural lands have experienced the greatest proportional change, while future growth is projected to shift more towards rangelands and forests.

Both FRAP and the Landis team plan to use the updated public and private conservation land ownership, as well as new Census data to feed into their respective models to refine projections and to determine how development patterns might change based on conservation investments. Future analysis can also examine which special-status species are most likely to be affected by development pressures.

Other indicators that could be used to describe the stresses on special-status species include the extent and rate of spread of invasive species, the concentrations of bioaccumulative substances in biota, the distribution and types of biomarkers that may indicate potential reproductive impairment, and the frequency, extent, and distribution of hillslope failures and other erosion and habitat degradation events. Discussions with state agencies and other conservation partners will articulate which indicators would be most appropriate for identifying and quantifying additional stressors on biodiversity.

Road Distribution

Habitat conversion is not the only stress factor contributing to losses in biodiversity. Fragmentation of habitats and loss of migration and dispersal corridors can have significant impacts on plant and animal communities. Roads are one widely accepted indicator of habitat fragmentation. They are often but not always correlated with croplands and urban areas. High road densities can increase the length of habitat edges and reduce buffer zones to interior areas that are important to some species. They can present physical barriers or increase the risk of injury or death to moving animals, particularly in areas of high traffic volumes or high-speed. Increased mileage of unpaved roads in areas of highly erodible soils, particularly if poorly constructed or maintained, can lead to increased soil erosion and loss of important vegetation. Human access can increase with increased road density because most people use roads to travel. Such access into sensitive areas, particularly during sensitive seasons such as breeding, can stress animals, especially those easily disturbed by human presence. In addition, roads, and especially the interstate highways and major state highways, can represent such formidable migration and dispersal barriers to some species that their ultimate effects can be equated to creating isolated habitat "islands." In fact, conservation biologists have been applying the well-established theory of island biogeography (Mac Arthur and Wilson, 1967) to their plant and animal population models to predict extirpation rates in fragmented habitat patches and the species most affected by fragmentation and isolation. The UCSB California Gap Analysis Program developed a road distribution data layer, using US Bureau of Census (TIGER) data. It shows paved and unpaved roads, with proportional "impact zones" on both sides of the roadway depending on the type of road. For example, the impact zone of freeways was considered to be about 1500 feet (500 meters) on either side, whereas 75 feet (25 m) was used for four-wheel-drive routes. These impact zones are simple spatial constructs that only suggest relative degrees of adverse impacts, rather than being based on research about the actual impacts themselves.

Figure 9 demonstrates that much of the state is close to a road. In fact, 21% of the state's land area is located within these impact zones. Roads are densest in habitats near urban areas of South Coast Region (coastal scrub, chaparral) and San Francisco Bay Area (grasslands, wetlands, hardwoods, chaparral), as well as agricultural lands in valley areas. Considerable road density occurs in forested lands of the northern Sierra, northeastern California, and along the north coast as well as the desert shrub lands of western Mojave. Low road densities occur in mountainous conifer forests and alpine lands of southern Sierra and Coast Ranges as well as in remote desert lands of Mojave and Colorado Deserts. Low road densities are explained by land management status, such as wilderness or national parks, as well as remoteness from population and steepness of topography.

Areas with both high richness index values for special status species and high road densities are the South Coast metropolitan area and southwestern San Joaquin Valley. Patterns for other areas with many rare species (North San Francisco Bay, Owens Valley, northern Shasta County) need further analysis before drawing conclusions about road impacts.

The data set has several problems when viewed at finer scales, including omissions (missing existing roads) and inaccuracies (showing some roads in wrong locations).

This dataset is derived from the TIGER 2000 Transportation layer from http://gis.ca.gov/data_index.epl

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It needs substantial improvements in road data, as well as research into understanding species and habitat sensitivity to road impacts, before making robust conclusions about what habitats or species are most likely to be affected.

The California GIS Council, a consortium of public agencies and private organizations, recognizes road data as an important statewide "framework" data set and has been discussing how to improve it. A lead agency for this effort has yet to be identified.

More detailed review and analysis is needed to determine the actual effects of these roads on natural resources and the degree to which roads represent dispersal, migration, and recruitment barriers. As described above, the impact to biodiversity depends on the width of the roadway and associated impact zones, road surface (paved/unpaved), construction, and maintenance, the soil type and habitats crossed by the road, the sensitivity of animals near roads, and the traffic volume and average speed. The hillslope monitoring data that CDF has collected on over 100 miles of forest roads over the past six years can be useful to highlight erosion features associated with forest roads throughout the private forestlands in California. We intend to summarize these important findings about road impacts on the surrounding landscape in future reports.

Species and habitats are stressed by numerous other factors, and discussions with our conservation partners can help articulate these questions. For example, what risks do specific habitats face in terms of invasive species, groundwater mining, disease, pollutant exposure, accelerated soil erosion, altered hydrologic functions and processes, and disturbed watershed dynamics? How have these factors already affected existing habitats? What levels of habitat fragmentation significantly affect which species? Where are the greatest potentials for conflicts or compatible uses between habitat conservation and other resource conservation or land use goals? Aquatic biodiversity has been and continues to be impacted by a myriad of human-induced stressors, given the continuing high demand on water resources for agricultural, residential, and industrial uses. Data compilation, analysis, and map development related to aquatic resources will take on a high priority for future reports.

Examples of Potential Management Response Indicators

Natural resource agencies and private organizations are responding to the needs of conserving species and habitats in a variety of ways, including private landowner incentives, regional conservation planning, land acquisition, and environmental regulations. Two factors that illustrate this response, and for which data are available statewide, are the distribution of public lands and regional conservation planning efforts.

Public and Conservation Lands

Some of the state's earliest public lands were established in the late 1800s and early 1900s – both as conservation lands (e.g. Yosemite) and for other public-use purposes in the form of national forests. Over time, the federal government added national parks, wilderness areas, military lands, and wildlife refuges. Almost half (47%) of the state is

now managed by federal agencies. These lands occur primarily in the forested areas of the northern part of the state, in the Sierra Nevada, and the desert regions (Figure 10).

State and local agencies, as well as private organizations, have been active in acquiring private lands for habitat and open space conservation. These lands are located throughout the state and represent 2% to 4% of the state's total land area.

Although there is interest in ensuring that examples of each habitat type are included in public conservation lands, several habitat types still are found predominantly (more than 80% of statewide distribution) on private lands where the presence and degree of land and ecosystem stewardship is varied and unknown. These habitats include valley oak woodland, blue oak-foothill pine woodland, coastal oak woodland, and coast redwood.

Three of the six areas with high index richness values for special-status plants (the Owens Valley area, Del Norte County, and the San Bernardino Mountains) and one of the three areas with high index values for special-status animals (Owens Valley area) occur primarily on public lands. It should be noted, however, that the fact that lands are in public ownership does not necessarily imply that these lands have been managed to confer a high degree of protection over special-status species and habitats, as evidenced in the case of the Owens Valley. Other important areas for special-status species (San Francisco Bay area, southern San Joaquin Valley, and southern San Diego County) occur mostly on private lands, with some intermix of public or conservation lands.

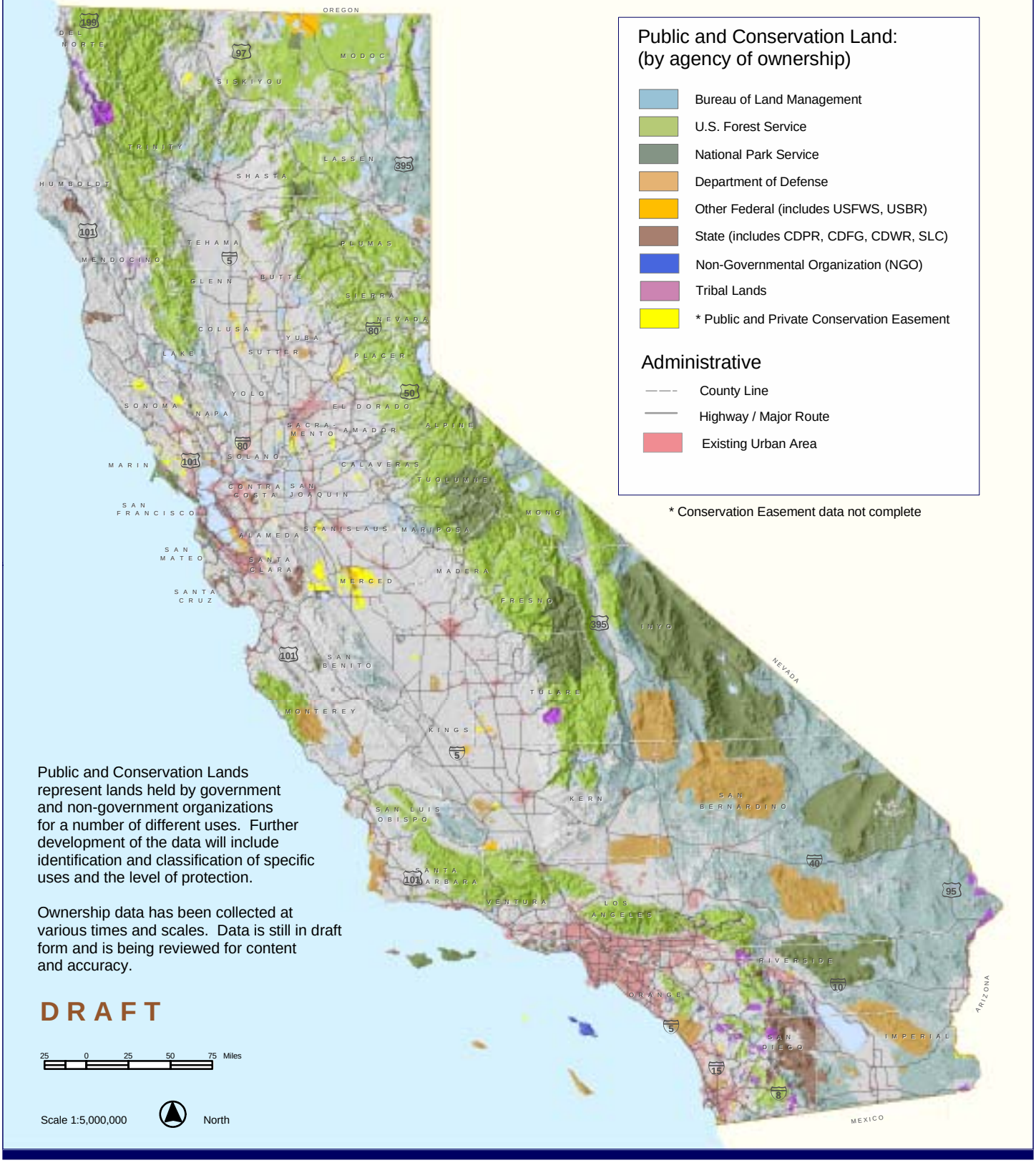
Land conservation strategies that keep the land in private hands but provide incentives for biodiversity and habitat maintenance can provide an important alternative approach to acquisition and are being increasingly considered as part of the mix of conservation investments. The conservation easements depicted in Figure 9 are an example of an alternative conservation strategy, although not all easements are depicted here.

Public and private conservation land ownership changes frequently, particularly for agencies and organizations active in conservation work. Maintaining current data on these lands requires ongoing efforts. No state or federal agency in California has responsibility for maintaining an integrated statewide coverage of these lands, and past efforts to do so have been opportunistic.

The Legacy Project, recognizing the importance of land ownership data, has collaborated with the CALFED agency consortium, to fund the first major update of this database in over seven years, focusing primarily on major state and federal agencies. The data set is a mosaic of ownership data from a variety of land-managing agencies and has only recently been completed. It should still be considered draft until it has been sufficiently reviewed by those agencies that contributed data. The data are most current for lands managed by the California Department of Parks and Recreation, the National Park Service, the CDFG, and the US Bureau of Land Management, which are among the most active agencies in real estate transfers. The data do not necessarily include a complete accounting of recent state acquisitions under Propositions 12, 13, and 40. Data for other agencies have either changed little in recent years or will need to be updated during the coming year.

CALIFORNIA LEGACY PROJECT

State of California resources AGENCY



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Land ownership data compiled by the U.S. Bureau of Reclamation, the CALFED Bay-Delta Program, and the California Resources Agency. Last updated and reconciled by VESTEA Resources Inc. in August 2002.

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The current data both underestimate and overestimate the level of protection provided to habitats. Underestimates are due to the rapidly changing nature of land ownership, with very recent acquisitions not being completely recorded and integrated into this data set. Overestimates may be inferred by assuming that the presence of a habitat on public lands confers a high level of protection. Many public lands are managed for multiple purposes, and some of these uses may degrade habitat quality.

The current dataset does not sufficiently classify public lands by differing types of management or protection status. The Project has committed funds during the coming year to further improve this dataset by updating miscellaneous state and federal lands, local government lands and private conservation lands. It is also working with the California GIS Council to find a more streamlined approach to integrating ownership and management data from these various agencies, hoping to eventually move to a parcel-based data set that will have even greater value for conservation planning. Future improvements can collect more detailed management status information about different lands to classify them by levels of habitat protection, commodity use, and recreation use.

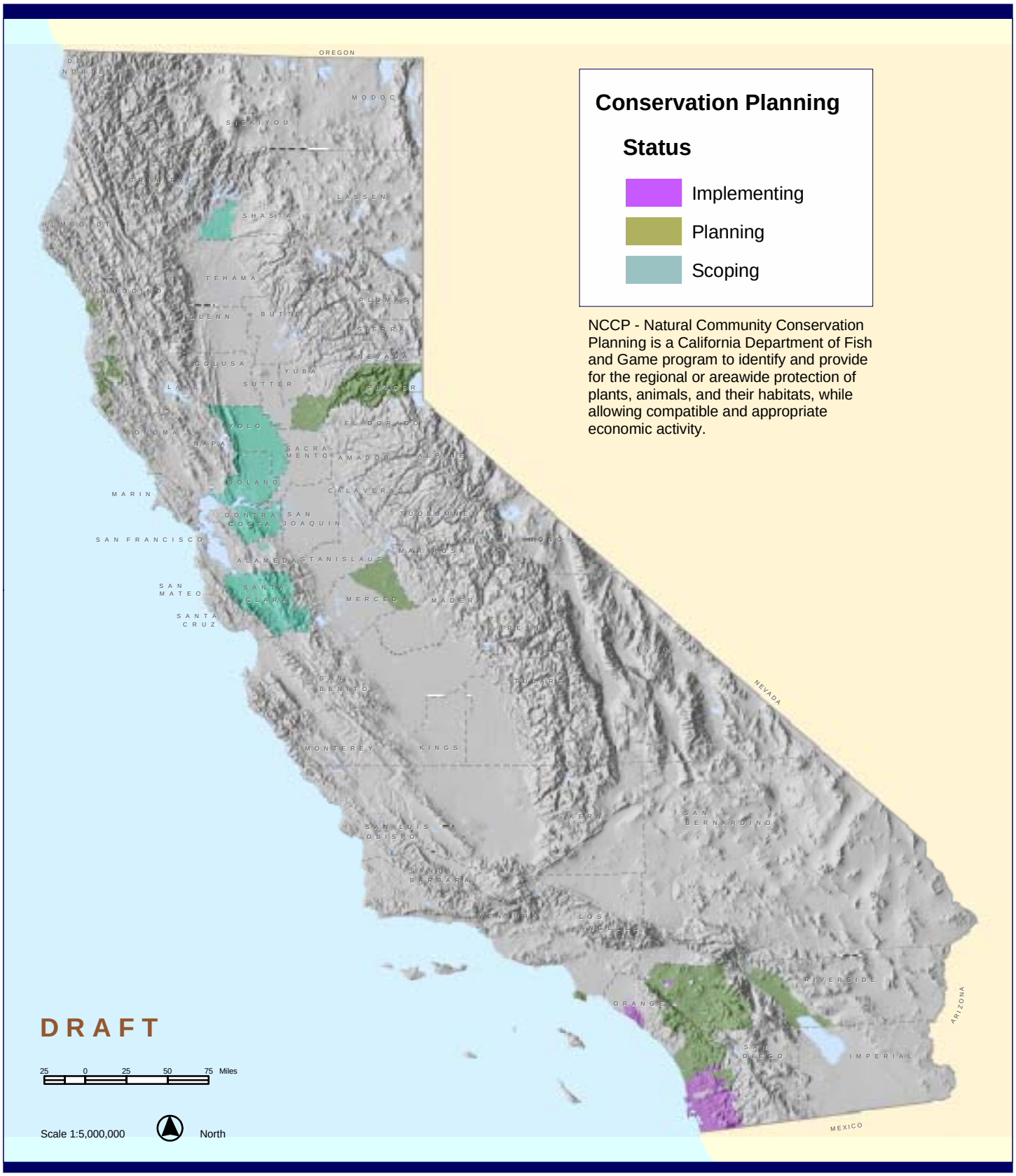
Regional Conservation Planning

One of the most long-standing, innovative approaches to regional conservation planning pioneered by the state and since emulated throughout the nation is CDFG's California Natural Community Conservation Planning (CNCCP). The CNCCP program creates regional conservation plans designed to protect entire communities of native plants and animals, while promoting local land use and regulatory systems that are more efficient, certain, and cost effective than other alternatives. It is an ecosystem approach that uses the best available conservation science and locally driven collaborative partnerships to provide long-term coverage of both special-status species, including both listed and unlisted species.

The Conservation Planning map (Figure 11) shows the planning boundaries of existing CNCCP plans. Generally, these conservation-planning areas are located where sufficient regulatory and economic incentives exist to enter into these kinds of planning processes. Areas with high risks to biological resources that do not have those incentives tend not to receive the same planning attention.

Natural Community Conservation Program plans, collectively, include many different habitat types, including conifer forest in the northern Sierra and North Coast, grasslands and wetlands of the San Francisco Bay and Delta Area, desert shrublands of the western Mojave, and coastal scrub and chaparral in the South Coast. These plans have been started, or are being implemented, in several areas with high species irreplaceability indices (South Coast, Colorado River, Kern County, parts of the San Francisco Bay Area, and Mendocino County).

Although no formal CNCCP efforts have been initiated in other biodiversity "hotspots", most of them, as well as ecosystems and landscapes of high public and biological value, such as Lake Tahoe, are receiving considerable conservation attention. Wetlands conservation efforts are quite active in the San Francisco Bay Area. The Owens Valley is undergoing a multi-agency-based multiple species recovery plan, and the Bureau of Land Management and National Park Service are developing conservation plans for the northern and eastern Mojave Desert.



NCCP/HCP Boundaries provided by the California Department of Fish and Game, Habitat Conservation Planning Branch.

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Several other important areas (Del Norte County, northern Shasta County, Southern Sierra, and the San Bernardino Mountains) occur primarily on U.S. Forest Service land, and the USFS is developing or implementing various conservation-focused plans in these areas.

The dataset upon which the conservation-planning map is based contains planning boundaries of other efforts, such as major watershed plans and Coordinated Resource Management Plans. Those plans are not shown in the current map to reduce complexity and improve readability. The dataset is relatively sparse in content, containing information only on the plan name, current status (CNCCP efforts only), and spatial extent. It does not provide information about specific priority areas (which are still being developed in most cases) to enable evaluation of special-status species and habitat distribution and abundance in relation to conservation planning and implementation efforts. It also does not contain summaries of the resources or proposed actions typically described in planning documents.

The Legacy Project is hosting a series of regional workshops designed, in part, to capture additional information about existing and emerging plans. Data on these plans will be integrated into a more complete and informative GIS layer. Future analyses will show zones of spatial overlap between plans as well as overlaps or gaps compared to important lands and natural resources.

B. Working Landscapes

California has some of the most productive and valuable farmland and forestland in the country and boasts large expanses of rangeland. Maintaining the maximum amount of the limited supply of these private "working landscapes" is a conservation priority and a policy objective enshrined in state law. Farmers, foresters, and rangeland owners and operators produce the agricultural and forest products that are the cornerstone of the rural and statewide economy. They also are caretakers of land and watersheds whose actions can maintain and protect – or diminish – water quality, air quality, wildlife habitat and other resources valuable to the public at large. The data in this section have been assembled to demonstrate a small sampling of the trends affecting these production landscapes focusing primarily on issues of the quantity of working lands – changes in acreage in productive use and forest cover – rather than quality, which require site-specific measurements and long-term monitoring to assemble. From a tax-revenue generation perspective, urban and commercial land uses are considered more valuable than agricultural or forested land uses (Miller and Hyslop, 2000). However, agriculture (including ranching) constitutes a large and stable (and increasing) contribution to the state's economy. Between 1996 and 2001, the agricultural sector output grew by more than $5 billion. In 2001, the output of California's agricultural sector was over $30 billion - larger than the economies of Alaska, South Dakota, Montana, Wyoming, North Dakota, or Vermont (California Agricultural Statistics Service, 2002; Wright, 2002). Paradoxically, landowners are facing static or in some cases declining income from their commodities. Combined with increasing costs, including those associated with environmental stewardship and landscape maintenance related to goals other than commodity production, many farmers and forest landowners are being forced to make difficult financial choices.

Forestlands and Timberlands

California ranks third in the nation, behind Oregon and Washington, in softwood lumber production and ninth in total cubic feet of softwood and hardwood harvested (lumber, biomass, pulp wood, etc.). Sales of saw logs, wood chips, fiber, and processed timber products amounted to almost one billion dollars in 1996. Timber commodities represent the third-ranking commodity category in California based on sales receipts behind farm- and rangeland-derived commodities (California Department of Forestry and Fire Protection 2002 in press).

The Fire and Resource Assessment Program of CDF periodically issues extensive reports on the condition of California's forests and rangelands. Several chapters of the Forest and Range 2002 Assessment are currently in review, and the full report is anticipated to be publicly available in late 2002. That report will cover a broad range of topics relating to forest and rangeland health, and, in recognition of the limitations of a commodity-centered assessment, will include a discussion of the social, natural, and economic capital considerations pertaining to California's forests. To avoid duplication with the forthcoming assessment by CDF, then, this current report will summarize only a small subset of the data that relate to the health and condition of California's extensive forestlands.

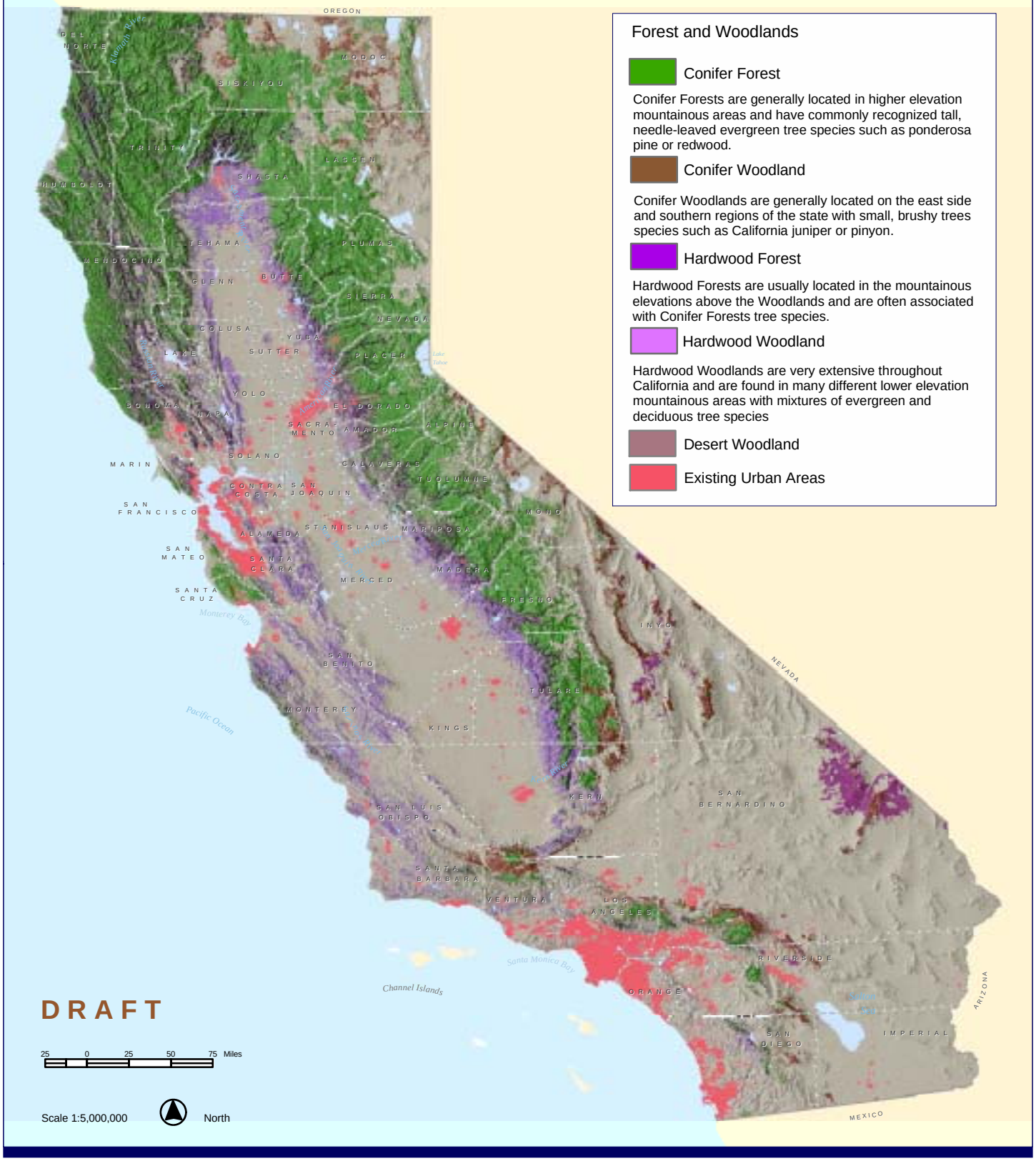
The indicators utilized in this report are those that can be used to provide a snapshot of forest extent, ownership, and management. Other indicators that could be used to describe the condition of timberlands include, for example, annual removal of wood products compared to the volume determined to be sustainable, extent and growing stock of plantations of native and exotic species, and forest productivity as expressed in mass of carbon photosynthesized per unit time or similar measures. Fortunately, a large number of indicators related to timberland and forest condition, health and vitality, watershed protection, and maintenance and enhancement of long-term multiple socio-economic benefits are already available and have been extensively used throughout the world. At their sixth meeting as the Montréal Process Working Group in Santiago, Chile, ten nations agreed in 1995 to a comprehensive set of criteria and indicators for forest conservation and sustainable management. This statement of endorsement is referred to as the "*Santiago Declaration*" (http://www.mpci.org/whatis/santiago_e.html). The forthcoming Forest and Range 2002 Assessment will describe the forestland indicator framework and report on those indicators for which statewide data exist.

Examples of Potential Condition Indicators

This report highlights three measures that can be used to describe the condition of California forests: generalized forest distribution, timber harvest volume, and land cover change. The forthcoming FRAP report will contain a series of additional indicators, such as ecological, geological, and hydrological processes beyond their range of historic variation.

Extent, Types, and Distribution of Forest Lands

Figure 12 shows the location and distribution of the broad categories of forests and woodlands in the state.



Land cover data created by the California Department of Forestry and Fire Protection. Last updated 2002. Forest habitat definitions from "Draft Forest and Range 2002 Assessment," California Department of Forestry and Fire Protection. Existing urban areas based on Department of Conservation Farmland Mapping and Monitoring Program data and John Landis, University of California at Berkeley.

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California has 31 million acres of forest, located primarily in coastal ranges, the Sierra Nevada, and the Klamath-Cascade region. Smaller forests occur in southern California. Half of the total acreage is categorized as timberland, forests capable of growing at least 20 ft^3 per acre per year of wood fiber. Over half (56%) of these timberlands are in public ownership. Industrial forest landowners own more than half (56%) of private timberlands. The California Department of Forestry and Fire Protection defines industrial forest landowners as a timber operator on 5,000 acres or more employing professional forestry staff, or the on-site operation of a commercial milling operation (California Department of Forestry and Fire Protection 1995).

Timber Production and Harvest Information

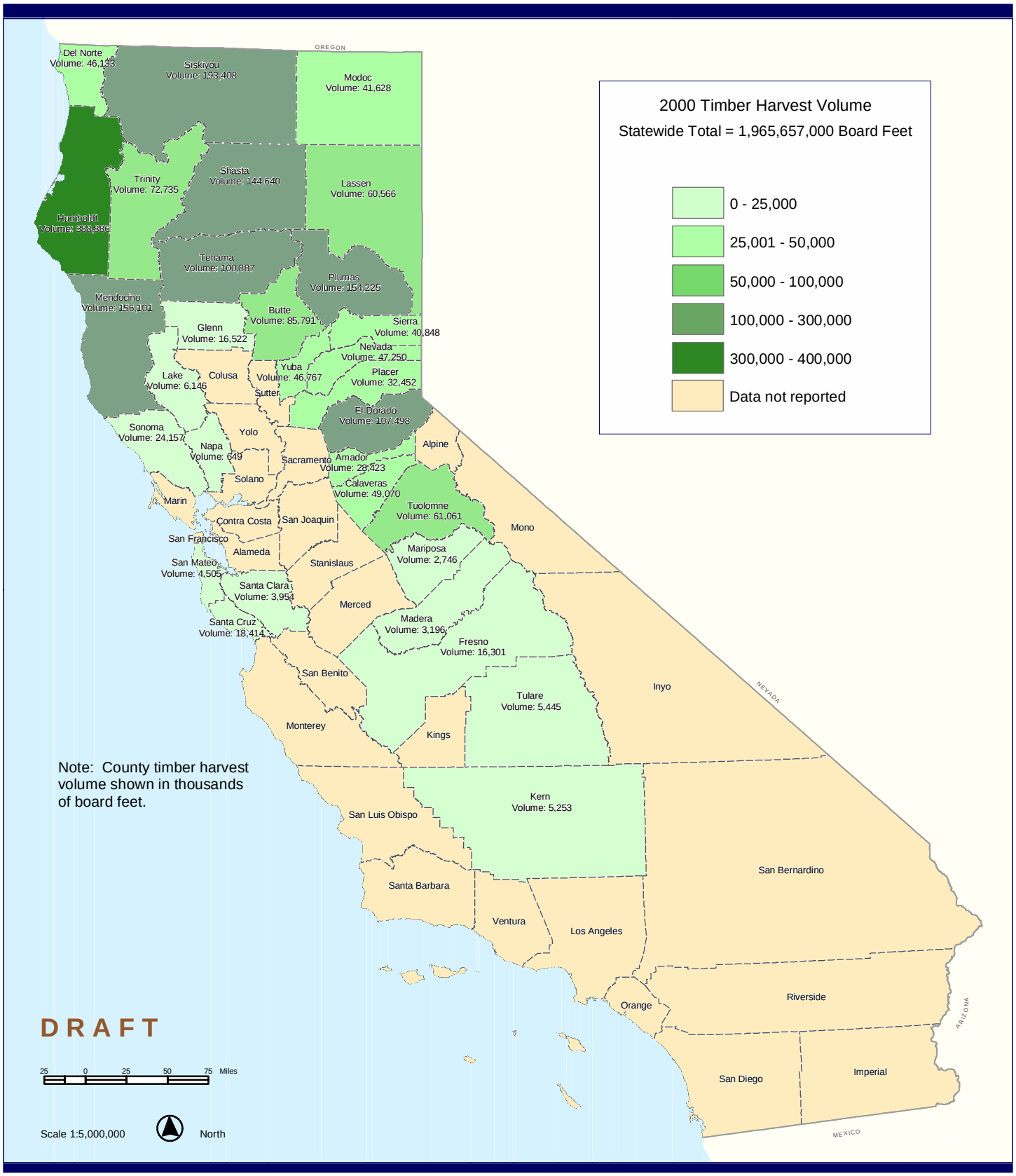
Figure 13 shows the volume of timber harvested in 2000 in those counties for which data are available. Some of the heavily forested counties in the Sierra Nevada do not produce a large volume of timber because they encompass federal lands managed in part for public trust values other than commodity production (e.g., species habitat, recreation, water supply). Also, the Sierra region contains three relatively large National Parks, and numerous wilderness areas that, while meeting the numeric classification of timberlands, are withdrawn from timber harvest. The North Coast and Klamath-Cascade regions contain relatively large amounts of private forestlands – and the highly productive forest species of coastal redwood and Douglas fir – managed for timber production. Along with the Klamath-Cascade region, the North Coast generates the bulk of the state's commercial timber. Counties leading timber production in the state are Humboldt, Siskiyou, Mendocino, Plumas, and Shasta Counties.

Land Cover Change

The CDF works collaboratively with the U.S. Forest Service to detect changes in forest and shrub canopy cover over much of the state. Figures 14 and 15 summarize these data by county, representing the period from 1991 to 1998. Figure 14 shows the proportion of forest cover change reported for each county by the magnitude of the change (regardless of cause). Figure 15 shows, for each county where cause could be determined, the proportion of all forest cover change – both degrees of loss and gain - categorized by a variety of causes. It should be noted that change over many acres could not be typed due to lack of data on attributable causes of loss or gain.

In terms of magnitude of change throughout the study area, 44% of the total change was in terms of small decreases, 18% decreased moderately, and 7% was due to large decreases. Results for increases showed that 28% of the total change was in terms of small increases and 3% was in terms of moderate to large increases. Thus, total decreases accounted for 69% of all the detected change. It should be noted, however, that the data do not easily lend themselves to estimating absolute number of acres lost or gained – only number of acres affected by small, moderate, or large degrees of change.

Among counties showing large decreases in vegetation, Shasta had the greatest number of acres with large decreases in vegetation: (21,604 acres), followed in distant second rank by Humboldt (4987 acres), Lake (3141 acres), and Mendocino (2876 acres).



Timber Harvest Information is based on the 2001 California Statistical Abstract

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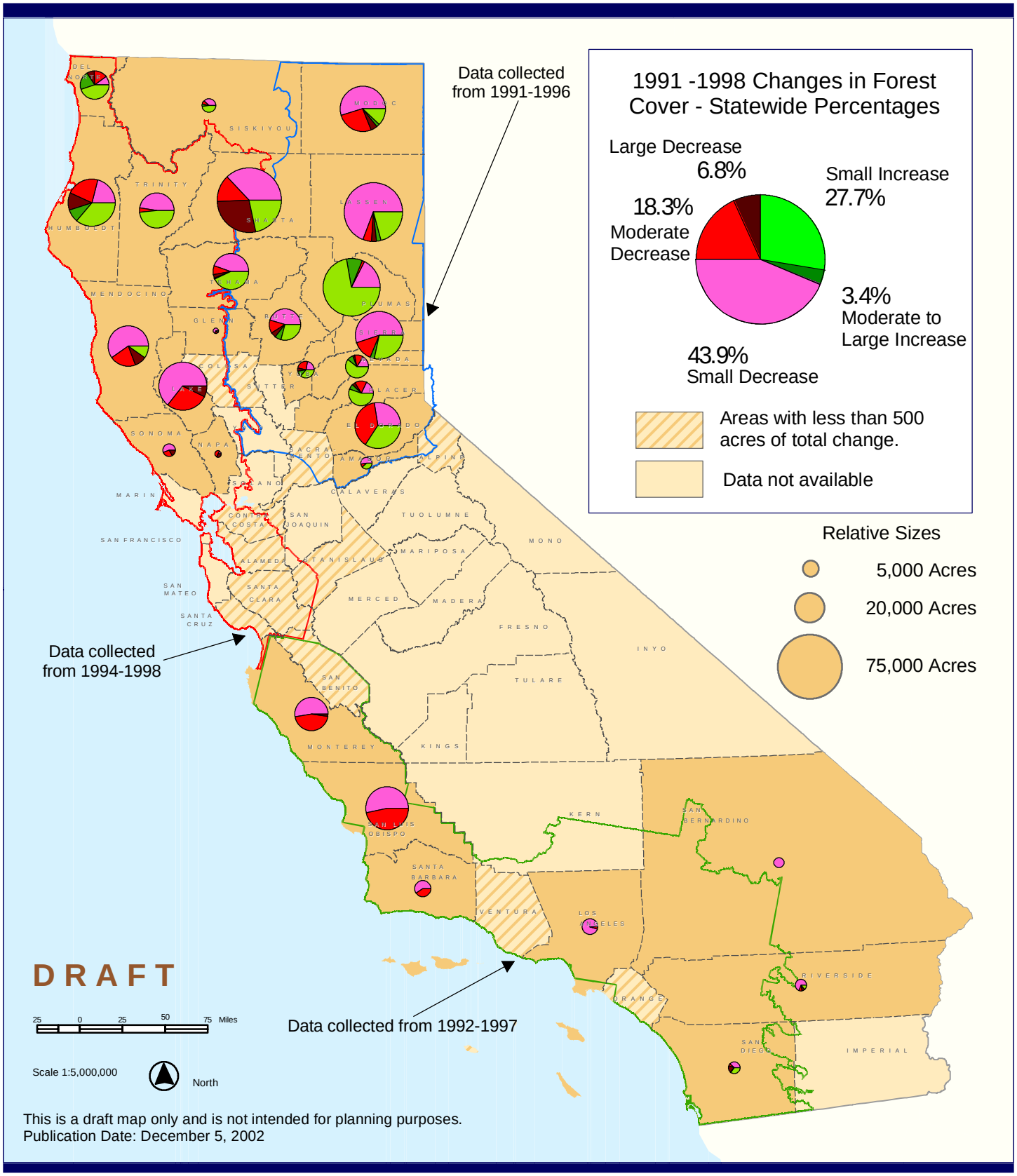
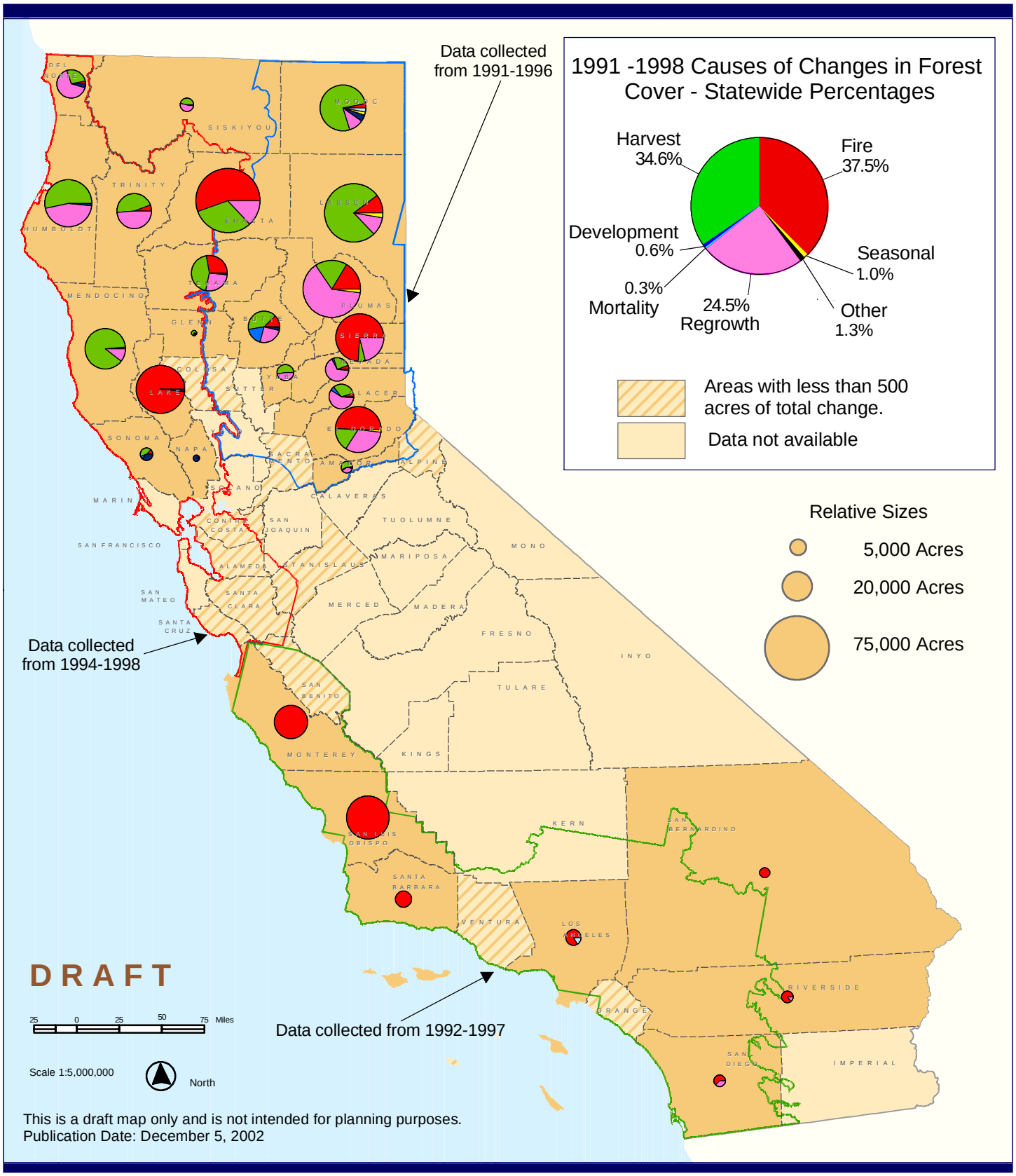


Land cover and land cover change detection data created by the California Department of Forestry and Fire Protection. Landsat Thematic Mapper (TM) satellite imagery is used to locate magnitudes of vegetation change within five-year time periods across all vegetation types and ownerships. Dataset collected from FRAP website http://frap.cdf.ca.gov/data/frapgisdata/select.asp

The California Land Cover Mapping & Monitoring Program (LCMMP) is a collaborative effort of the USDA Forest Service and CDF to map and assess changes in California's vegetation.



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The California Land Cover Mapping & Monitoring Program (LCMMP) is a collaborative effort of the USDA Forest Service and CDF to map and assess changes in California's vegetation.

For counties showing moderate decreases in vegetation, San Luis Obispo (16,188 acres), El Dorado (15,041 acres), and Lake (12,625 acres) showed the greatest acreage in the “moderate” loss category. Other counties with moderate loss included, in descending order, Shasta, Modoc, Monterey, Humboldt, Mendocino, and Sierra.

Counties with moderate to large increases in vegetation include Plumas (5420 acres), Humboldt (3622 acres), and Del Norte (3206 acres) showed the largest acreage increase.

In terms of causes for change throughout the study area, fire was responsible for 37% of all change, harvest for 35% of all change, re-growth for 25%, and mortality for 0.3%.

Among all those acres changed due to fire statewide, much of it (77%) was in the form of small to moderate decreases, whereas only 11% of the acreage changed by fire resulted in large decreases. Counties with largest total of acres burned are, in decreasing order, Lake (43,095 acres), Shasta (43,045 acres), San Luis Obispo (34,783 acres), Sierra (32,166 acres), Monterey (20,596 acres) and El Dorado (19,240 acres).

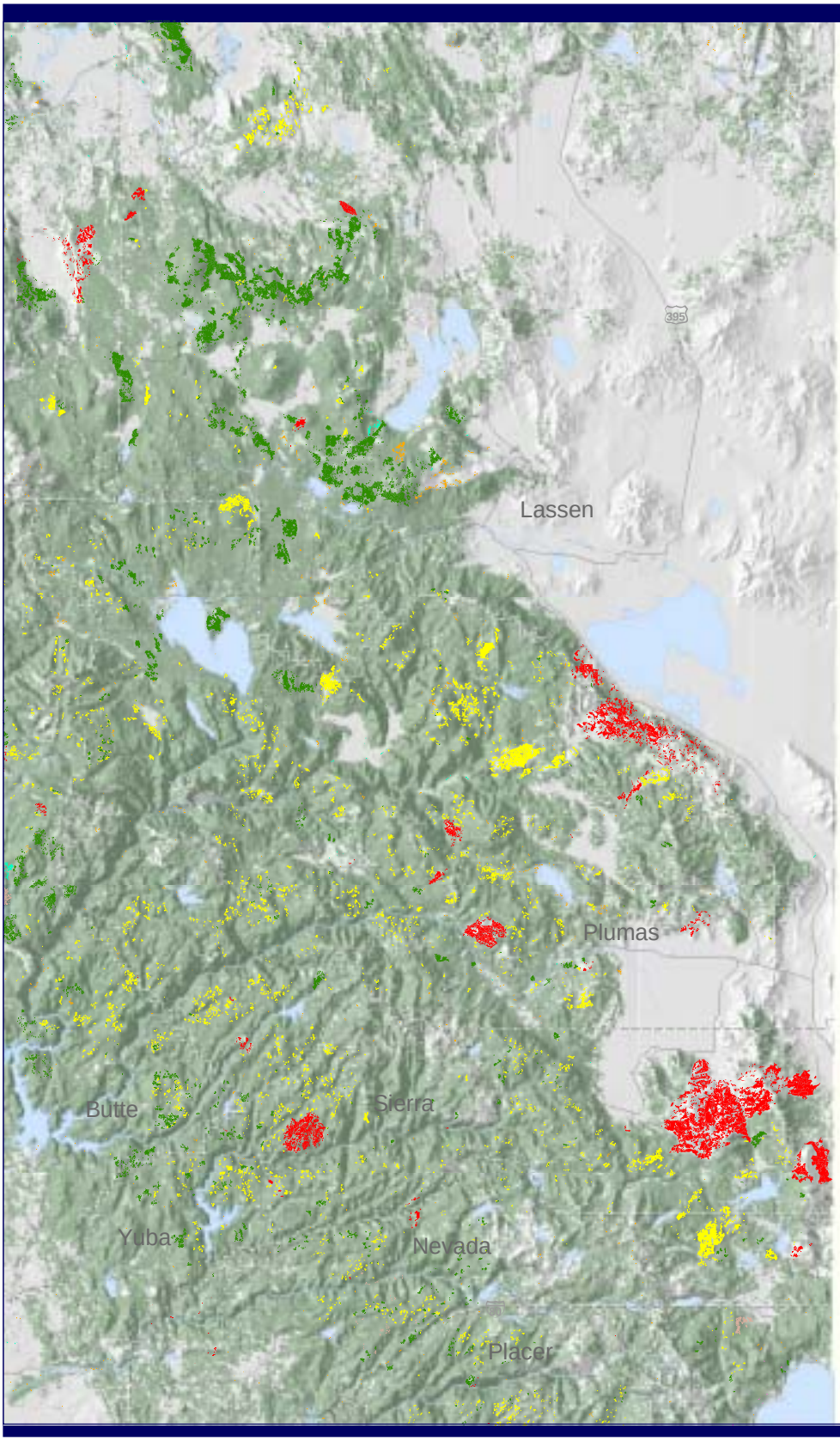
Of the forest acreage changed by harvest, much of it (89%) resulted in small to moderate decreases, with only 7% of the acreage experiencing large decreases. Lassen County experienced the largest total acres of forest harvested (49,562 acres). In distant second rank were Modoc (30,106 acres), followed by Mendocino (27,453 acres), Shasta (24,543 acres), and Humboldt (22,258 acres).

Most of the change in forest cover due to mortality (93%) resulted in small decreases. This data set showed forest mortality in only 6 counties, with Modoc having the largest acreage (1,122 acres), followed by Los Angeles (717 acres) and El Dorado (168 acres).

Among those acres where re-growth occurred, much of it (89%) was in the form of small increases. However, 10% of the re-growth resulted in moderate to large increases. The counties with the largest total acres of re-growth were Plumas (39,322 acres), followed in distant second rank by Humboldt (18,674 acres), El Dorado (12,569 acres), Trinity (11,225 acres), Shasta (10,118 acres) and Del Norte (10,103 acres).

Figure 16 depicts a close-up of forest cover change in northeastern California and the various causes of change. Even at the close-up scale of this map, it is difficult to identify absolute changes in forest cover.

It should be noted that changes in vegetative cover are highly dynamic and based on a number of key factors, among them the age of any given stand of trees (younger stands tend to be denser), the species composition (monoculture plantations tend to be more affected by disease than highly diverse forests), the timber harvest status and conservation status, and the fuel load and fire susceptibility. Young forests tend to be more highly combustible than older stands. Forests in drier regions of the state and near urban areas with high fuel accumulation of brush, dead and dying trees, tend to have greater fire frequency, intensity and extent than moister areas of the state that are in less accessible places, having older, taller trees with little under-story and low fuel load. Therefore, forest cover trend assessments will have to occur over relatively long time periods to evaluate long-lasting or permanent loss of forest cover.



1991 -1996 Changes in Forest Cover

Cause of Change

- Fire
- Harvest
- *Development
- *Mortality
- Regrowth
- *Other
- *Seasonal

Land Cover

- Forest and Woodlands
- Other

*Not visible at this scale.

California Location Map

DRAFT

5 0 5 10 15 Miles

Scale 1:1,000,000 North

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The California Land Cover Mapping & Monitoring Program (LCMMP) is a collaborative effort of the USDA Forest Service and CDF to map and assess changes in California's vegetation.

Example of Potential Stressor Indicators

As mentioned above, forest lands face many stressors, including outright conversion, timber harvest, wildfire, and pest outbreaks. These and many other stressors will be described in greater detail in the forthcoming Forest and Range Assessment (FRAP) Report. One example stressor for the purposes of this report that can be drawn from the FRAP efforts is the conversion of forestland to developed uses.

Forestland Conversion

Forestland conversions have altered California's landscapes substantially since the advent of European settlement. A comprehensive survey of land use changes from 1950 to 1980 found that 837,000 acres of forestland were converted to agricultural or urban uses, comprised of 220,000 acres of conifer forestland and 617,000 acres of hardwood forests. Even greater amounts were converted prior to 1950 (California Department of Forestry and Fire Protection, 1988). Forest land conversion to other land uses (grazing, urban, crop land, low-density rural residential) has slowed considerably in recent years, although the losses are still substantial, totaling approximately 75,000 acres in the ten-year period between 1984 and 1994 (California Department of Forestry and Fire Protection, in press). About 170,000 additional acres were taken out of production during the same ten-year period by administrative action. These conversions are depicted in Figures 7 and 8, respectively.

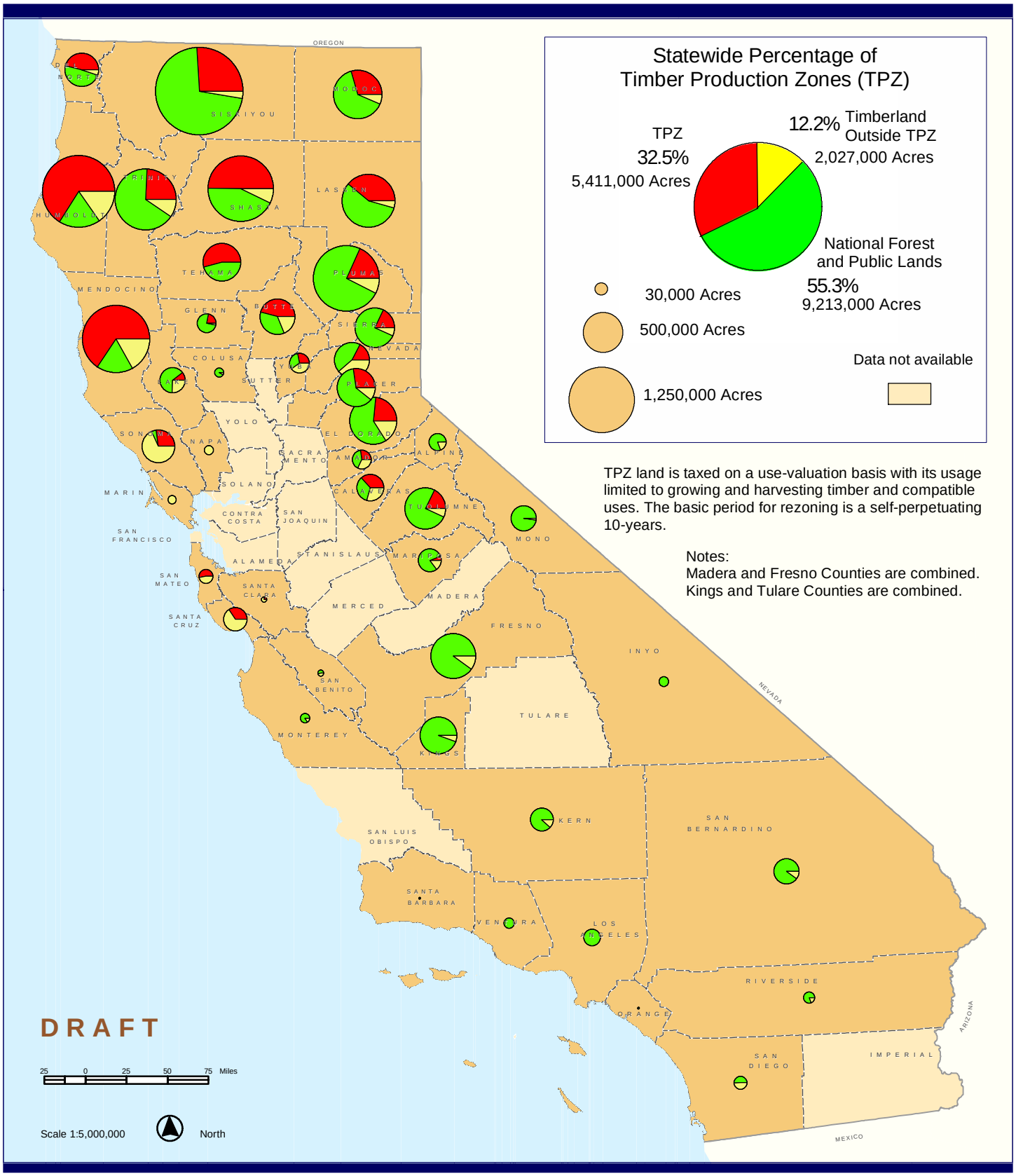
While this report does not contain a detailed analysis of forestlands threatened by future development conversion, it is possible to examine the proximity of forests (Figure 12) to current and projected residential development areas (Figures 7 and 8). Increased housing density is likely to affect hardwood forests substantially more than the higher elevation or more remote conifer forests as new communities are built away from, but still within commuting distance of, existing urban areas. This urban and rural residential expansion is also likely to significantly convert important farmlands, particularly in the Central Valley, and will be discussed below.

As with forest condition indicators, numerous other stressor indicators for forests have been developed and widely adopted worldwide, including those related to the institutional and policy framework. The CDF 2002 Assessment will cover most of these indicators, such as the extent to which forests are affected by processes or agents beyond the range of historic variation, extent of forest land subjected to levels of specific air pollutants, the extent of significant soil erosion, etc. We will evaluate, after public distribution of the CDF 2002 Assessment, together with our conservation partners, which of these indicators are particularly important in the context of facilitating conservation investment decisions and should be further developed.

Example of Potential Management Response Indicators

Timber Production Zones

One of the ways that California has sought to maintain the land base of private timberlands is to modify property tax assessment and collection for productive forestlands. Forest landowners within county-designated Timber Production Zones (TPZ) can choose to commit their land for forest uses for ten years. In exchange, land is taxed on a schedule related only to timber growing rather than “highest and best use”,



Source: California Department of Finance
Areas of Timberland and Ownership in California
http://www.dof.ca.gov/html/fs_data/stat-abs/tables/g29.xls

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which could include development values. County assessors' offices administer the program. Much like the Williamson Act enrollments for farmlands, these deferrals automatically renew unless the landowner or the local government takes action. Currently, 5.4 million acres in 32 counties are zoned as TPZ (Shih, 2002). In addition, an undetermined amount of non-industrial timberland is commingled with farming and rangelands that are zoned for agricultural uses under the Williamson Act (California Department of Forestry and Fire Protection 1995).

Like other tax-deferred conservation programs, TPZ zoning is a tool that has limited ability to ensure the long-term protection of working forest landscapes. While previous research indicated that nearly all industrial private forest landowners (99%) were covered by TPZ, only about 73% of all private timberlands are zoned for TPZ. That research means that there is an upper boundary of 55% of non-industrial private timberland owners that could be enrolled in the TPZ program.[3] If that proportion continues to reflect current zoning, some 1.3 million acres of productive timberland is zoned and taxed for some category other than timber production. This suggests that landowners or counties may be planning to utilize these lands for something other than timber production. As noted above, land can be taken out of TPZ by landowners or local governments – either through immediate rezoning for development, which triggers tax recoupment fees, or by non-renewal of TPZ contracts. At least one report has noted that forest landowners frequently initiate non-renewal in anticipation of potential conversion to other land uses, such as urban development (California Department of Forestry and Fire Protection 1995).

Figure 17 shows the number of acres of private timberland that are included within or lying outside of Timber Production Zones in reporting counties in 2001. Timberland acreages in federal and other public ownership – which is not included in the TPZ program – are depicted for illustrative purposes.

Comparing this map to the change-detection maps, four of the top five counties with highest acreage of forest converted due to development (Butte with 3458 acres, followed by Placer, El Dorado, and Sonoma with 200-560 acres each) had about 25% of their forest lands in TPZ. The fifth county, Nevada, has less than 20% of its forestlands in TPZ. The two counties with the highest percentage of their land in TPZ (Humboldt and Mendocino) had fewer than 12 acres of forest (combined) converted due to development.

Crop and Grazing Lands

California has by far the largest agricultural production of any state in the nation. The long list of agricultural commodities produced on these lands and for which California is among the leading producers in the nation and the world, includes both specialty and staple crops. In 2001, California produced $30 billion worth of farm commodities – more than twice as much as second-ranking Texas, while one county, Tulare, generated more agricultural receipts than all of Oregon's counties combined (Texas Agricultural Statistics Service, 2002; Oregon Agricultural Statistics Service, 2002). Vegetables alone were responsible for $5.9 billion in farm gate sales, whereas fruit and nut crops exceeded $9 billion.

[3] Previous CDF research has shown that while nearly all industrial timberland owners are covered by TPZ zoning, only 47% of non-industrial private forestland owners are (CDF 1988).

Animal production – including dairy and meat production – accounted for some $8 billion in 2001 (California Agricultural Statistics Service 2002). In 2000, California's two largest commodities – milk and grapes – both led the nation with 19 and 91 percent of gross national receipts, respectively (California Department of Forestry and Fire Protection 2002).

While agriculture is big business in California, crop and grazing lands also sustain local communities and, in many cases, provide valuable ecological services to society at large. Unfortunately, few current data can adequately depict these services. Thus, the following section describes crop and grazing land conditions primarily in terms of the distribution and extent of various agricultural lands across the state and the gross value of agricultural production as a condition indicator depicting the economic importance of agricultural commodities by county. Many stressors, including economic factors that contribute to decreased capacity of the land to generate revenue, impact commodity-production landscapes. In this first cursory assessment, the example stressor indicator described below focuses on past and projected conversion rates of farmland to non-agricultural uses. The examples of management responses to agricultural land conversion used in this report are application of Williamson Act, zoning, and agricultural conservation easements.

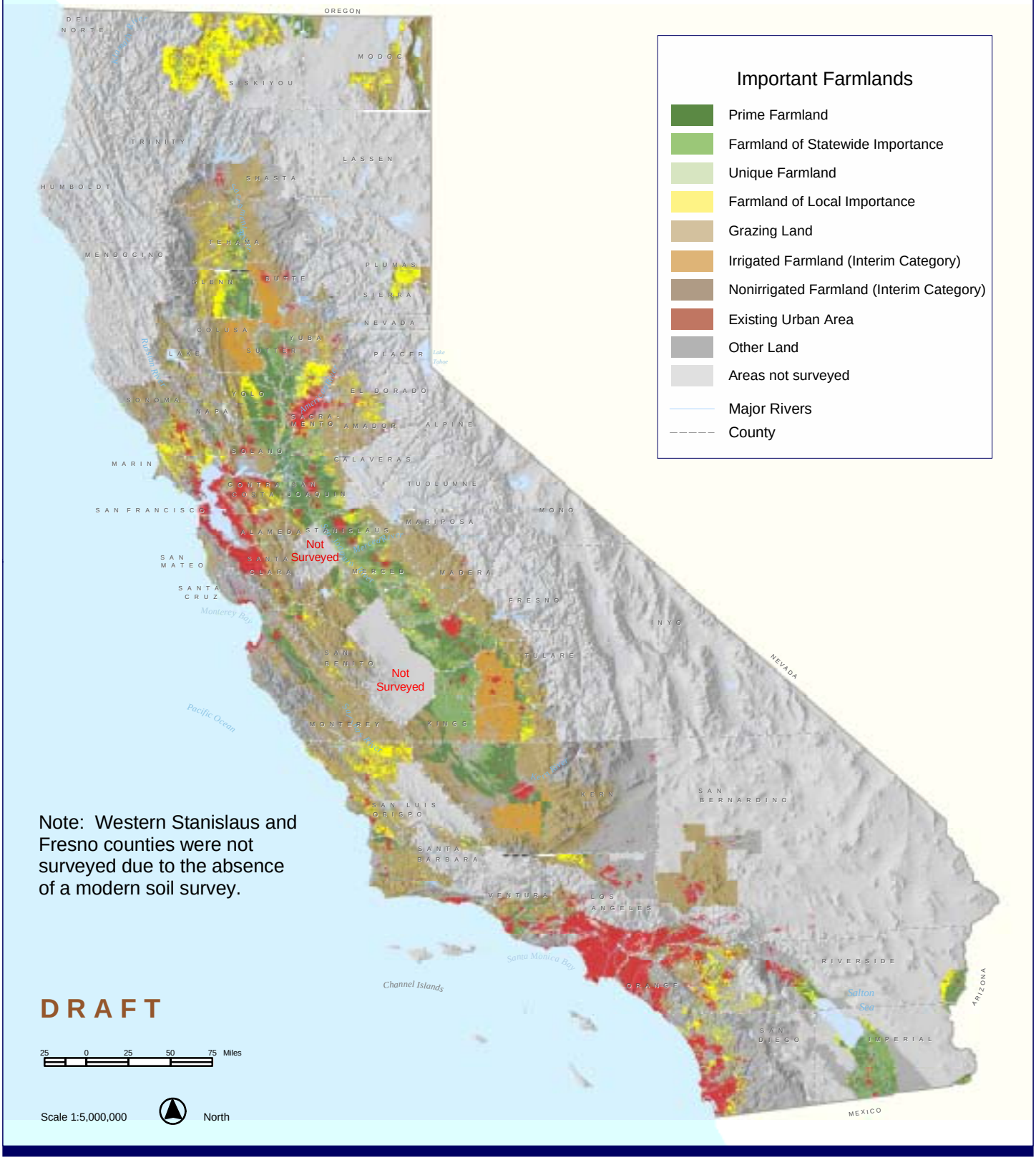
Examples of Potential Condition Indicators

This first resource assessment provides two examples of condition indicators: Distribution of crop and grazing lands, and gross annual value of agricultural production. Future resource health and condition reports might include additional indicators of farm and grazing land condition, such as ancillary service and ecological values of agricultural landscapes, sustainability indices, and a variety of socio-economic measures.

Distribution of Crop and Grazing Lands

California's 87,500 farms – including cropland, orchards, and pastures – are the state's most extensive network of "working landscapes," covering some 27.8 million acres (CDFA 2002). The diversity of California's farm production in some way reflects the diverse farming landscape upon which farm products grow. While there are many potential ways of assessing condition of agricultural lands – ranging from soil properties to water availability – this report relies primarily on data compiled by the Farmland Mapping and Monitoring Program (FMMP) at the California Department of Conservation. The FMMP tracks changes to the farmland base, and, every two years, produces detailed maps of farmland for most counties. It has devised a number of categories that capture this diversity in a way that can be analyzed at a statewide level. For mapping purposes, as shown in Figure 18, this report aggregates FMMP's categories as "farmland" (irrigated lands such as prime, of statewide importance, and unique), "grazing land" (both rangeland and non-irrigated croplands), and "other" (non-agricultural) lands. The definitions for FMMP mapping categories are shown in Appendix A.

As Figure 18 demonstrates, prime farmland, farmland of statewide importance, and unique farmland are concentrated in the central valley and the central coast, and irrigated lands in the extreme southern portion of the state. Farmland of local importance and grazing land are both far more evenly distributed throughout the state.



1998 Important farmlands data created by the Department of Conservation Farmland Mapping and Monitoring Program.
Existing urban areas based on Department of Conservation Farmland Mapping and Monitoring Program data and John Landis, University of California at Berkeley.

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The Department of Conservation has compiled and systematized Natural Resource Conservation Service (NRCS) soils data. There nevertheless are a number of counties, or portions of counties, for which there are gaps in the FMMP data. The FMMP program maps 90% of the state's private lands on a two-year update cycle. The data depend on information from aerial photos to delineate land use as well as USDA Natural Resource Conservation Service soils data. Some of the counties displayed as "not surveyed", such as western Stanislaus and western Fresno counties did not have updated soils data that are needed for FMMP mapping. Western Stanislaus County has been added to the FMMP survey area as of 2000, and future maps will reflect updates. Since the FMMP is tailored to tracking the ebbs and flows of agricultural land, it is not necessarily suited to answer other questions associated with farmland – such as the location of high-value commodities and changes in crops, and where they are grown. In addition, because it uses a minimum mapping size of 10 acres and soil-based classifications, not all agricultural lands are adequately depicted in the FMMP data – such as the high value nursery and greenhouse operations in the South Coast region of the state. Therefore, in order to utilize the core data of the FMMP to better monitor farmland for conservation purposes, increased funding and better cooperation with counties with unique situations are required.

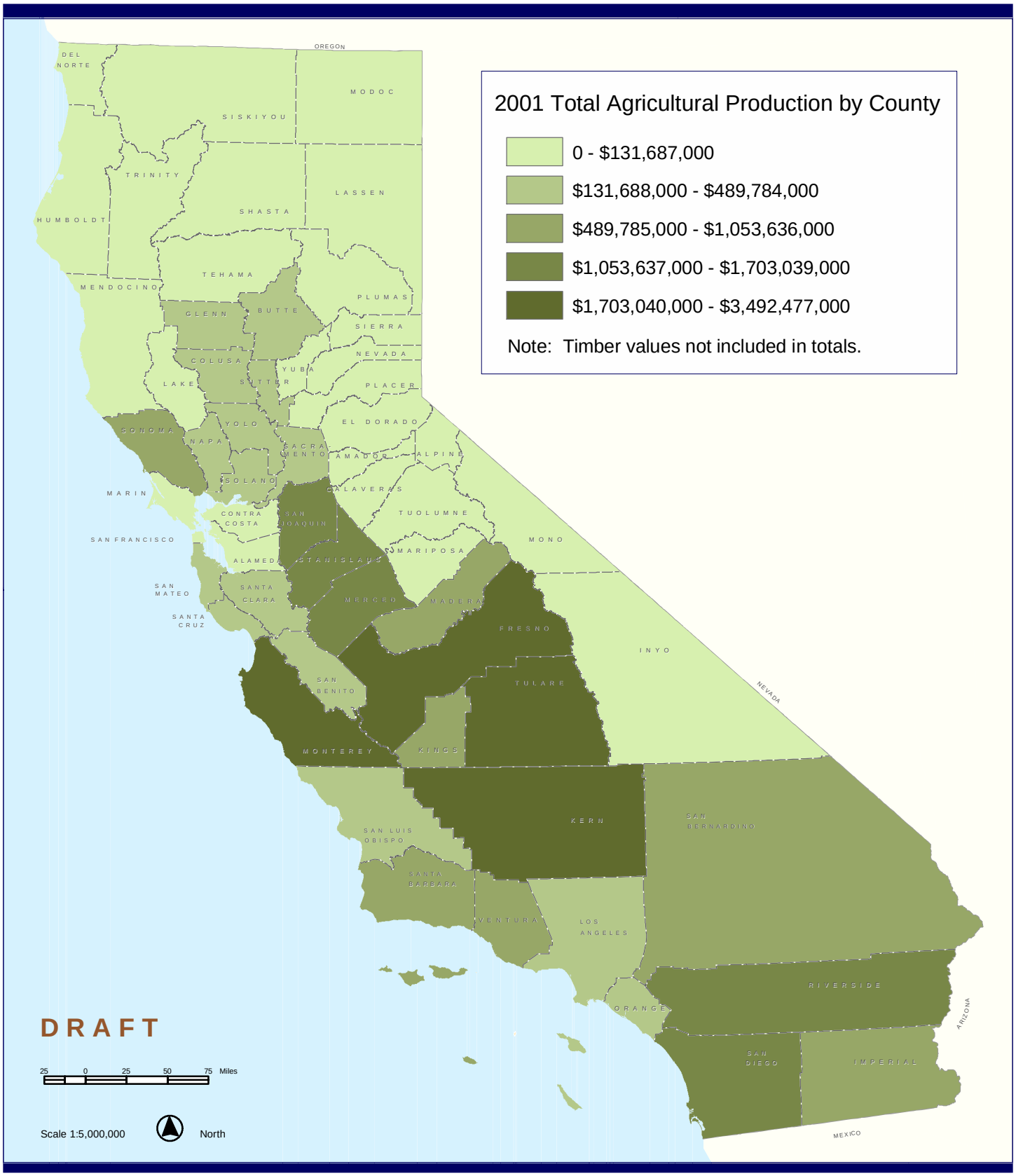
Gross Value of Agricultural Production

Data from the California Agricultural Statistics Service show the 2001 gross value of agricultural production (Figure 19). Counties depicted in the two darkest shades of green each produce more than $1 billion in farm gate sales. Tulare, Fresno, Monterey, and Kern are the top grossing counties, in descending order. The total value for these four counties ($11.7M) exceeds the sum total of the lowest 49 counties ($11.2M). These four counties received their greatest value from the following commodities: Fresno - cotton, grapes, poultry, milk; Kern - grapes, citrus, milk, cotton/cottonseed; Monterey - lettuce, strawberries, broccoli, grapes; and Tulare - milk, oranges, cattle, grapes.

The top grossing commodities in the state are (with top producing counties in parentheses): Milk and cream (Tulare, Merced, Stanislaus, San Bernardino, and Kings); grapes (Kern, Sonoma, Tulare, Napa, Fresno); nursery products (San Diego, Orange, Ventura, Los Angeles, Santa Clara); cattle and milk (Tulare, Fresno, Imperial, Merced, San Bernardino); lettuce (Monterey, Imperial, Fresno, Santa Barbara, San Benito); and citrus (Tulare, Kern, Fresno, Riverside, Ventura).

Example of Potential Stressor Indicators

Cropland and grazing lands are broad landscapes that are subjected to many environmental and human-made stressors. These range from climatic to biophysical and can include many diseases, pests, and pathogens that thrive in agricultural systems. In addition, a wide range of agricultural management practices may put the long-term viability of farming and rangeland landscapes at risk, resulting in soil loss and loss of organic matter in soil, accumulation of residues of harmful soil minerals and synthetic chemicals, and depletion and pollution of aquifers and surface waters, among others. Furthermore, the sustainability of commodity-producing landscapes is also threatened by strong market forces beyond local, regional, or even state control. Examples of these "stressors" are numerous.



Source: Summary of County Agricultural Commissioners' Reports, 2001
California Agricultural Statistics Service
ftp://www.nass.usda.gov/pub/nass/ca/AgComm/200108cavb00.pdf

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They include distorted market systems, trade imbalances leading to high relative costs for U.S. produce and lower demand abroad, and a myriad of other factors that negatively affect the economic viability of farms managed in accordance with sustainability principles. Also, agricultural lands near the urban interface tend to experience increasing conflicts related to dust, noise, odors, or concerns about pesticide use.

All of these stressors, whether direct or indirect, are contributing to accelerated conversion of agricultural lands. Only in rare cases can farmers pass on to consumers the costs of environmental management, particularly when the supply of a particular commodity exceeds demand and therefore suppresses prices. This contributes to a decreased ability to generate the revenue to remain viable.

While we have insufficient data at this time to discuss economic stressors impacting commodity landscapes, we do know that change in human settlement patterns has substantial impacts on the sustainability of working landscapes and therefore will be discussed below as an example of a stressor indicator.

Conversion of Crop and Grazing Lands to Other Land Uses

California boasts the largest population of any state in the nation at more than 34 million people. Urban areas have grown to accommodate this burgeoning population, and this growth has spilled over onto prime agricultural lands at an estimated rate of close to 50,000 acres per year. Unlike pathogens, for example, which only temporarily affect a landscape, the construction of infrastructure such as paved roads and dwellings that accompany human settlement can permanently alter a landscape.

The Department of Conservation's Farmland Mapping and Monitoring Program continuously tracks the status and trends of agricultural lands, and publishes a biennial analysis entitled the "California Farmland Conversion Report" that details the conversions of farmland on a statewide[4] and regional basis. In summarizing its findings for 1996-1998, FMMP reported that large acreages of monitored agricultural lands[5] were converted to urban land (see Figures 20-21). Between 1996 and 1998, 69,885 acres of farmland were converted to urban uses – an increase of 25% over the amount of conversion recorded in the previous two-year period (California Department of Conservation 2000). Such conversion of agricultural lands to urban is clearly demonstrated throughout Central and Southern California (Fig 22), where farmlands and grazing lands represent 30-90% of all lands converted to urban areas, depending on the county. Approximately 90% of the urban lands in Sutter, Yolo, Merced, San Benito, and Madera counties came from farmlands or grazing lands.

In addition, irrigated farmland[6] was converted to other uses including low-density rural residential housing, new or larger livestock facilities, wildlife habitat reserves, and mining activity (Figure 20).

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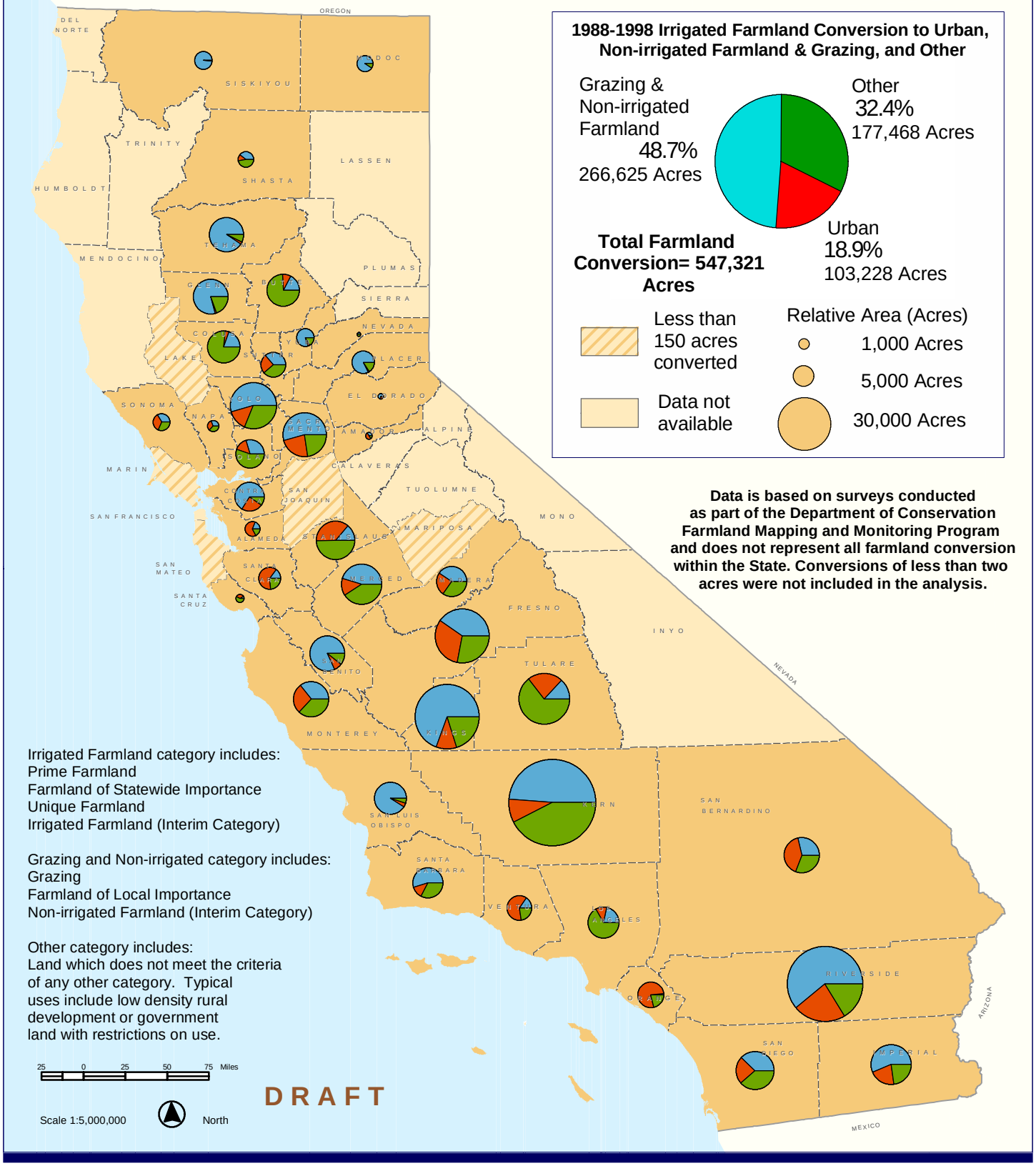
[4] As noted above, the FMMP data are not truly statewide – data are collected and reported for an estimated 90% of the state's private lands.

[6] Irrigated Farmland includes Prime Farmland, Farmland of Statewide Importance, Unique Farmland, and Irrigated Farmland (interim). Non-irrigated farmland includes Farmland of Local Importance and Grazing Land.



Farmland conversion analysis is based on California Department of Conservation Farmland Mapping and Monitoring Program data.

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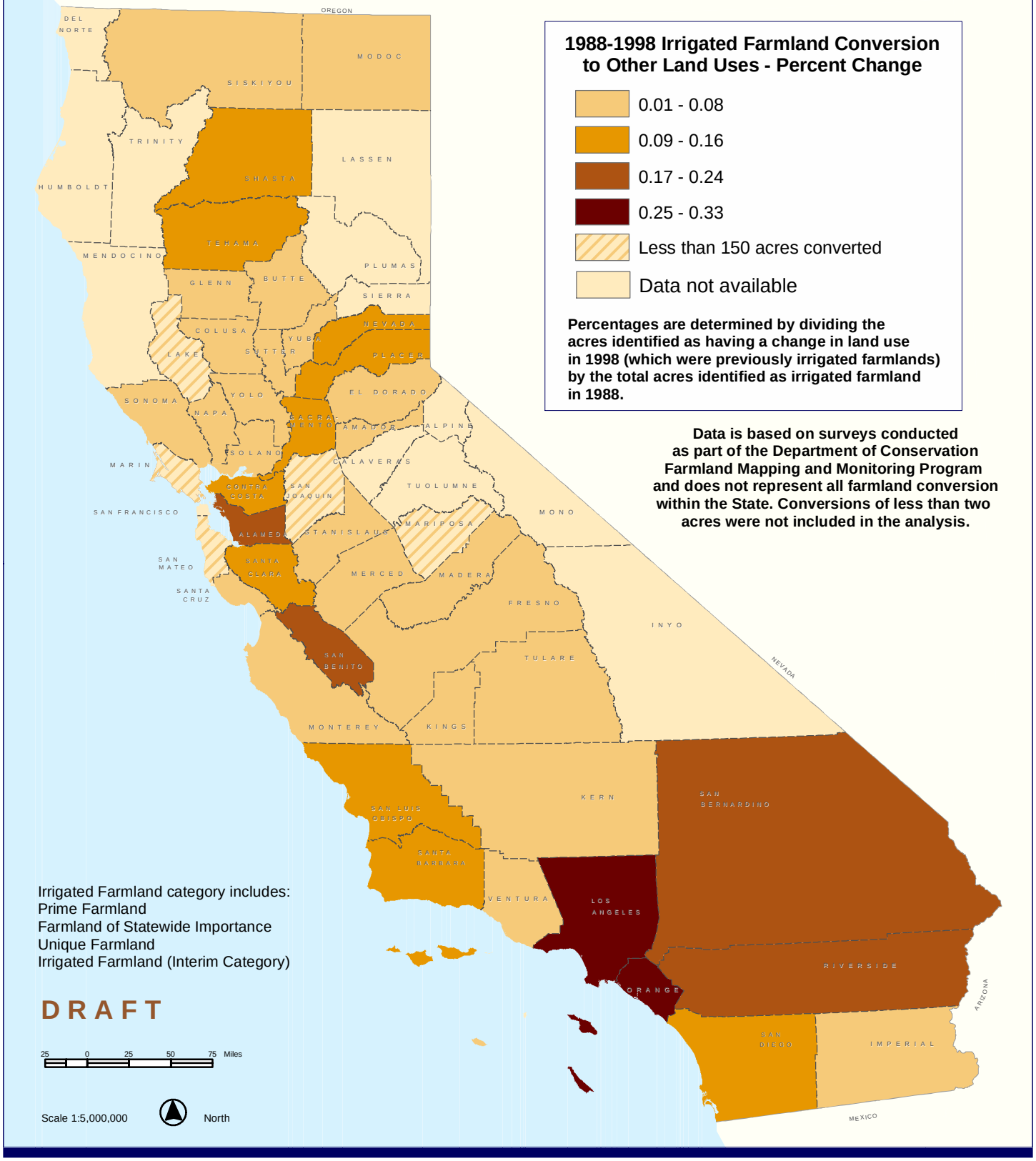

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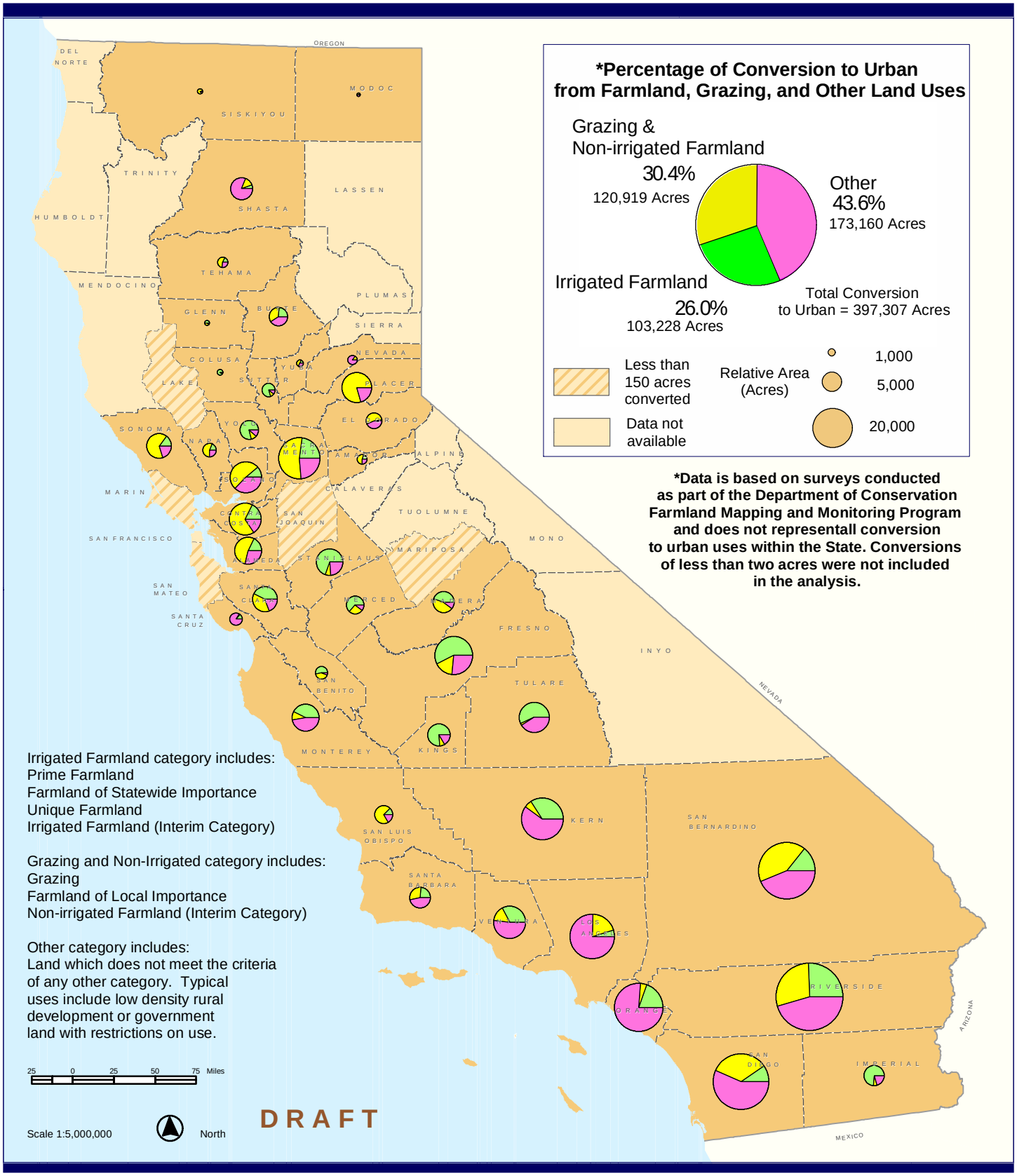

Urban conversion analysis is based on California Department of Conservation Farmland Mapping and Monitoring Program data.

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In short, irrigated agriculture is lost to a multiplicity of "uses," and even "non-uses" as when it lies fallow for three consecutive mapping periods. The FMMP has recognized the value of further categorizing the types of land uses to which agricultural lands are being converted and will begin a pilot program in late 2002 to collect data on a variety of conversion types that are currently grouped in the "other" category.

These landscape changes – some of which are part of a normal "ebb and flow" of land uses driven by local or regional economies (the fallowing of a field), and some of which are driven by migrations of people (the building of rural residences) – are part of the dynamism of the agricultural landscape that is tracked by the FMMP. Further analysis of these data in future reports could be designed to illustrate these dynamics.

Given this dynamic landscape, it should not be surprising that some lands also come into the agricultural land base during a mapping period. For instance, 150,760 acres of previously uncultivated or non-irrigated lands came under irrigation between 1996 and 1998. Even accounting for this new irrigated land, however, the FMMP showed a statewide net decrease of 40,473 acres of (mapped) irrigated farmland during the 1996-1998 period from 9.02 million acres to 8.98 million acres. Figures 20 and 21 draw heavily on the work of the FMMP to depict at a regional and county scale the stressor category of conversion on the highest value farmland (aggregated into an "irrigated" farmland category) between 1988 and 1998. As Figure 20 shows, many counties in the state experienced a loss of irrigated agricultural land during the period, some on quite a large scale (relative scales are depicted by the size of the pie charts on each reporting county). For example, in two Southern California counties (Ventura and Orange), and two Bay Area Counties (Santa Clara and Alameda) the majority of irrigated cropland loss was due to conversion to urban uses. Many counties in various regions saw irrigated farmland being converted to the "other "category, which includes large amounts of rural residential housing, although this category only constituted the majority of farmland conversion in Butte, Colusa, Solano, Tulare, and Los Angeles Counties.

Many counties also saw once irrigated croplands revert to non-irrigated or grazing uses during the 1988-1998 period. While that phenomenon is less permanent than residential development, it may have profound effects on local economies or be an indicator of potential future development as investments on agricultural lands are curtailed. Such conversion constituted the majority of conversions in Siskiyou, Modoc, Tehama, Glenn, Contra Costa, San Benito, Kings, San Luis Obispo, Santa Barbara, Riverside, and Imperial Counties.

Figure 21 depicts similar information to Figure 20, but emphasizes the proportional loss of irrigated farmland (as compared to the total agricultural acres lost). What it shows most strikingly is that in the populated and rapidly growing areas of the state, the loss of even a relatively small amount of irrigated farmland can be a loss of a considerable percentage of the remaining prime farmland base. While many counties in the fast-growing Sacramento metropolitan region, San Francisco Bay Area, and South Coast region demonstrate this phenomenon, the trend holds true even in central coastal and northern Central Valley counties. Particularly affected by this loss of irrigated agricultural land were (1) the South Coast counties of Los Angeles and Orange, which lost more than 25% of their remaining irrigated agricultural lands respectively, and (2) the San Francisco Bay Area counties, where Marin and Alameda counties lost more than 17% of their remaining irrigated lands.

Comparisons of Figures 19, 20, and 21 show that four of the top five counties in terms of loss of total irrigated farmland acreage between 1988 and 1998 (Kern, Riverside, Fresno, and Tulare) were also among the most economically productive counties in the state during 2001. However, for all of them except Riverside, this loss represented a relatively small percentage of their overall irrigated farmland acreage. In the case of Riverside, which depends mostly on dairy and nursery stock, loss of irrigated farmland would make little difference in the production of those commodities. Los Angeles and Orange counties experienced the greatest percentages of loss in their irrigated farmland, but again this probably affected their primary commodities (nursery stock and cut flowers) relatively little. Future analyses may focus in more detail on the relationships between loss of farmland acreage and the impacts on local economies and other resource values.

Figure 22 draws on the FMMP data – the most comprehensive set of statewide data on urban development – to depict the "source" lands of what became urban land during the 1988-1998 period. These data were collected by the FMMP through surveys and are not comprehensive for all urbanization in the state during that time. Figure 19 provides a useful corroboration of some of the other data described in this section. Namely, urban development is having a significant impact on farm and rangeland. If non-respondent urban areas and other jurisdictions that constitute the data gap are consistent with areas that reported, more than half of all urbanization is occurring on agricultural lands. This pattern is consistent with the observations of others that have noted that agricultural lands provide desirable lands for development, owing to their (frequently) flat topography and the fact that their development costs are generally lower than steeper, rockier, or more vegetated terrain.

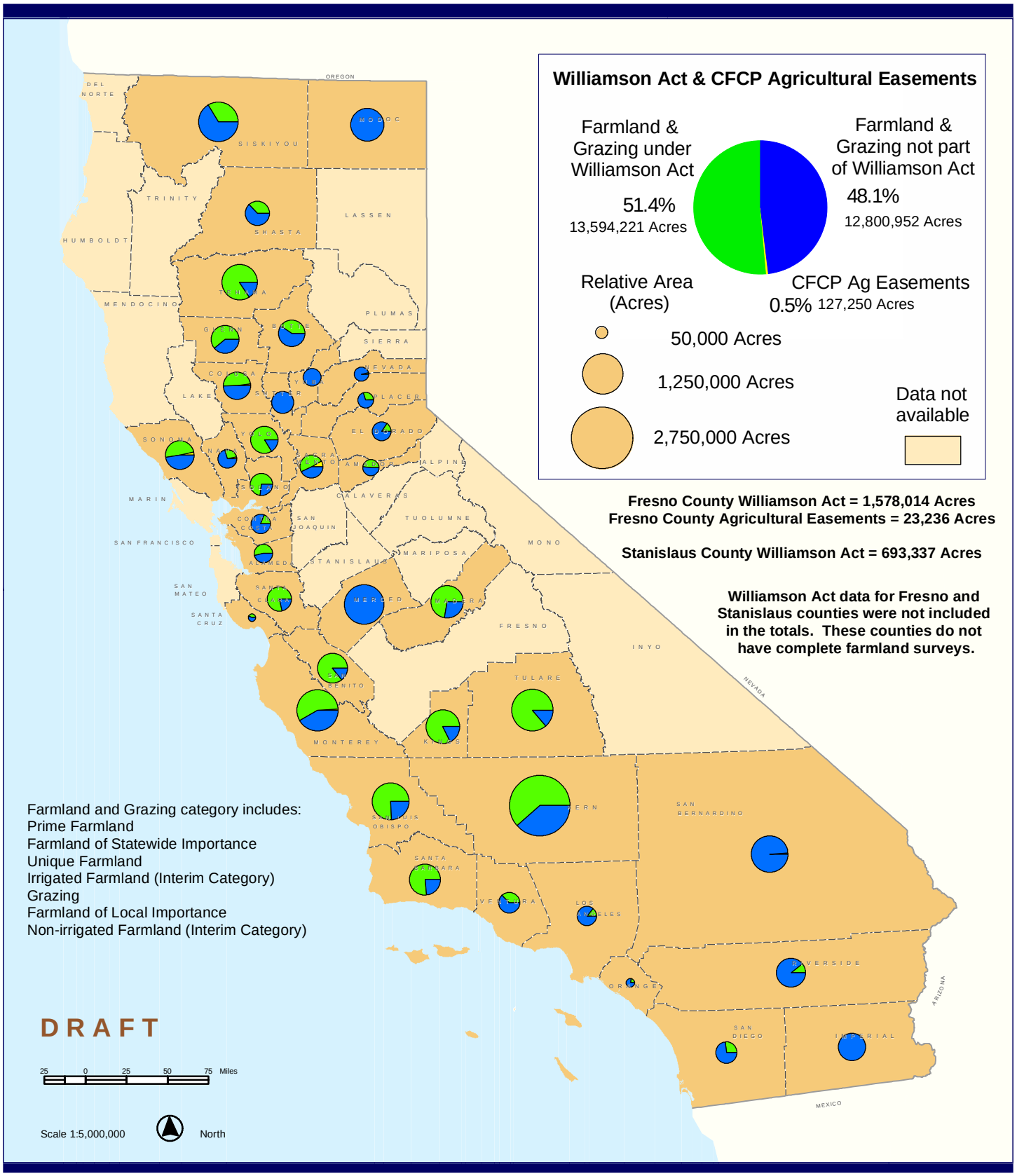
Future reports will have the opportunity to evaluate the use of additional stressor indicators in facilitating and informing conservation investments in landscapes producing agricultural commodities. These may include rates and extent of soil erosion, extent and rates of groundwater overdraft, extent and degree of conflict with other societal goals, as well as policy and institutional barriers to preserving sustainable commodity production.

Example of Management Response Indicator

Williamson Act Enrolled Land and Conservation Easements

State and local governments have developed and implemented a host of policies and programs to address farmland protection. Agricultural zoning, "right to farm" measures, and local agricultural and open space districts are but a short list of these programs.

Figure 23 depicts two statewide tools used to conserve farmland that have been mapped by the FMMP. The areas depicted as enrolled under the Williamson Act and agricultural conservation easements can be characterized as lands that can be reasonably maintained in future agricultural uses without the threat of being converted into urban uses in the near term. The Department of Conservation administers the Williamson Act as well as the state's acquisition of agricultural conservation easements.



Williamson Act and CFCP Agricultural Easement data compiled by the California Department of Conservation.

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Fifty-three of California's 58 counties participate in the Williamson Act, and only one important agricultural county (Yolo) has opted out. Participating counties determine some key factors for their own jurisdictions, such as minimum parcel size suitable for Williamson Act status, and which activities qualify as "agriculture" under the Williamson Act.

While agricultural conservation easements generally confer permanent protections, enrollment under the Williamson Act does not provide complete assurance against conversion of agricultural lands to more developed uses.[7] The Williamson Act's rolling 10-year contracts are very similar to those under the Timber Production Zone Program, which used the Williamson Act as a model. They provide significant incentives for landowners to maintain their land in agricultural uses through the use of reduced property tax payments. However, similar to TPZ, land can be taken out of Williamson Act contracts by landowners or local governments – either through immediate rezoning for development, which triggers a significant financial penalty, or by non-renewal of contracts. Non-renewal in anticipation of potential conversion to other land uses, such as urban development, is therefore as likely under the Williamson Act as it is under the TPZ Program.

Figure 23 depicts the relative application of the Williamson Act to agricultural lands. As that map demonstrates, not every county with high agricultural production has even the majority of their agricultural lands enrolled under the Williamson Act. However, those that do include Tehama, Glenn, Yolo, Sonoma, Solano, Alameda, Santa Clara, San Benito, Madera, Monterey, Kings, Tulare, Kern, San Luis Obispo, and Santa Barbara. There is a particularly low percentage participation in the program in Modoc County, in the Sacramento Valley, Merced County, the Sierra Foothills, and Southern California.

Comparison of Figures 19 and 23 shows that three of the top nine counties in terms of gross value of agricultural production had more than 60% of their agricultural lands enrolled under Williamson Act (data were not complete for three of these counties – Fresno, Stanislaus, and San Joaquin). Three of the nine top counties, however, had relatively little land enrolled under the Williamson Act. San Diego has less than 30% of its agricultural land, Riverside has 10%, and Merced had no lands enrolled until 2001 and is therefore not reflected in Figure 23.

III. Next Steps

As highlighted above, implementation of the resource assessment methodology relies heavily on effective partnerships with state resource agencies whose missions give them responsibilities over natural resource protection, recreation, and working landscapes. The Legacy Project needs to expand on the existing data partnerships it has already initiated and begin an interagency discussion of statewide assessment goals. The Project needs to understand the direction, goals, and needs of current assessment programs and to identify their respective agencies' priority management questions. Based upon this work, a collaborative effort can develop statewide assessment goals and key management questions that address both the Project's needs as well as those

[7] Just as enrollment in the Williamson Act programs does not accord permanent conservation, it is not reasonable to conclude that farmland not covered by agricultural easements or Williamson Act contracts are imminently threatened with conversion.

of its partners. These products will guide the development of critical conceptual models, selection of appropriate natural resource indicators, and identification of priority data needs and analyses.

The Legacy Project needs to continue and expand its efforts at improving the quality of statewide data sets, in collaboration with other agencies and organizations. With additional support, the California GIS Council could provide an effective coordinating role in this regard. The sections above describe the Project's interagency data efforts on public and conservation lands, vegetation, habitat linkages and conservation plans. Project staff is also pursuing interagency efforts at improving statewide data on wetlands and coastal fish, as well as integrating eco-risk and toxicological data from the California Environmental Protection Agency with other spatial natural resource data.

As described above, the Legacy Project needs to address issues of data scope, compilation and integration, gaps, and interpretation. Staff needs to assess the ability of existing data collection efforts to answer statewide questions and to recommend improvements of these efforts. Earlier reports and ongoing efforts by the Legacy Project show that there are key data and analysis gaps to help decision-makers determine whether conservation investments they are considering maximize benefits compared to other potential investments. These conclusions should focus the efforts of the Legacy Project on filling data and analysis gaps important to its departments, boards, conservancies and commissions. Data standards, similar to those being developed for vegetation, will need to be developed for some topics to improve the integration of existing data development efforts. Regional data sets can play an important role in statewide assessments. They need to be catalogued (using CERES as clearinghouse), evaluated for usefulness at a statewide level, and integrated with other, similar regional or statewide data sets.

Although statewide goals and management questions are important to identify priority data gaps and assessment efforts, some of these gaps are already clearly recognized by agencies. These include:

- Continual improvement of CNDDB, including better linkage with other more-focused sensitive species databases;
- Higher resolution existing vegetation data, using a more-detailed classification system;
- Improved modeling of historical vegetation patterns to use for comparison;
- Continual improvement of data on public lands and conservation lands to include both fee-title and easements of all public agencies and private conservation organizations. This needs to include more information about current land management prescriptions to help evaluate levels of habitat protection. Eventually these data need to be linked to county parcel data to be most useful for conservation planners;
- Continual improvement of data about existing and emerging conservation plans, including priority areas for conservation within each plan;
- Fish distribution and abundance, as well as passage obstacles (current effort already underway);
- Compilation and integration of county general plan and land use data;
- Invasive species (both plants and animals) distribution, abundance, and impacts on native species and habitats;
- Identification of important habitat linkages;

- ü Higher quality road data, describing road surface types, widths, average traffic volume, and physical barriers, such as concrete median walls, that impede movement of animals;
- ü Watershed processes and functions.

The Legacy Project needs to work with state agencies to design meaningful analyses of these and other data sets and to properly interpret the results. Conceptual models will help clarify how individual stress factors, such as habitat conversion, roads, and invasive species, affect individual natural resources. They will also help explain how agency actions respond to these stresses and what obstacles stand in the way of intended responses.

Future reports will be able to summarize results from assessment reports currently in draft stages and point readers to those reports for more detailed information.

The resource assessment methodology lays out an ambitious, but realistic, workplan for assessing the health and condition of the state's lands and natural resources. Such an approach is only possible however, as long as it is understood to be an incremental process that gradually provides more and better results with each iteration.

IV. Conclusions

This report illustrates how the Legacy Project's resource assessment methodology can be applied in iterative fashion to describe condition, stressors, and management responses for conserving biodiversity and working landscapes. The degree to which each assessment report improves depends on the level of collaboration achieved with state agencies, the degree with which existing assessment programs can answer statewide questions, and the level of funding for both the Legacy Project and other agency assessment programs.

For each example indicator, the report summarizes current knowledge and provides maps to illustrate geographic differences across the state. Observations about each map, as well as comparison of patters among maps, require more robust analysis before drawing definitive conclusions or recommending management actions. The report describes several options for these types of future analyses, which can be addressed with continued and increased funding. Some of these analyses are in progress by other state agency assessment programs, and their results will be integrated into future assessment reports. Each section above also provides suggestions for other types of indicators that agencies can use for informing their management decisions.

Despite the need for additional analysis, the report provides several obvious conclusions about the status and trends of lands and natural resources, based on existing data. On the minus side of the balance sheet are the following conclusions:

(1) Conversion of land to accommodate human population growth is a continuing major stress factor on both working landscapes and biodiversity, especially in areas with many special-status species and near the urban fringe. Growth projections indicate increasing impacts in the foothills, the lower to mid-elevations of the Sierra Nevada, and the eastern side of the Central Valley, thus predicting

particular pressure on oak woodland habitats and perhaps reducing the extent of lands available for timber production;
(2) Several habitats (oak woodlands and coast redwoods) occur predominantly on private lands. Although efforts to improve private land stewardship are ongoing, much of these habitats remain at risk of conversion to residential land uses;
(3) Seven additional species are presumed or possibly extinct since the last report card on the state of U.S. plants and animals was issued in 1997;
(4) More than 224,000 acres of cropland and grazing land were converted to urban land uses between 1988 and 1998. In central and southern California, farmlands and grazing lands represent 30-90% of all lands converted to urban areas. Approximately 90% of the urban lands in Sutter, Yolo, Merced, San Benito, and Madera counties were converted from former farmlands or grazing lands;
(5) Three of the nine top-ranking counties in terms of gross agricultural output (San Diego, Riverside, and Merced) had relatively little land enrolled under the Williamson Act, suggesting that these lands may be at risk of conversion to urban uses.

The data allow us to draw some conclusions on the positive side of the balance sheet as well:

(1) The most recent urban development trends, based on a single modeling approach, seem to indicate that the ratio of “greenfield” to in-fill development is decreasing, i.e., population growth within existing urban areas has increased, and urban expansion onto adjacent lands seems to have slowed recently in some areas of the state. It remains to be seen, however, if this very recent trend will become established over the long term;
(2) Increased funding to meet a variety of conservation objectives for working landscapes, open space, and biodiversity protection has become available;
(3) Coordinated, holistic, and stakeholder-driven protection and restoration efforts are increasing throughout the state. Regional planning efforts such as the California Natural Communities Conservation Planning process are being initiated or implemented in several parts of the state. These plans are focusing on some, but not all, of the areas with the highest numbers of special-status species. Other types of conservation planning, such as the CALFED Bay-Delta Program and Coordinated Resource Management Plans are also in progress to meet important conservation needs;
(4) Four of the top five counties with the highest acreage of forestland lost due to development between 1990 and 1998 have between 65% and 91% of their private timberlands enrolled in Timber Production Zones (TPZ). Enrollment in TPZ slows forest conversion;
(5) Three of the top nine counties in terms of gross agricultural productivity had more than 60% of their agricultural lands enrolled under Williamson Act.

Future assessments will be able to summarize pertinent results from individual reports currently in draft stages and point readers to those reports for more detailed information.

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Appendix A:

Categories utilized by the California Department of Conservation's Farmland Mapping and Monitoring Program.

Irrigated Farmland

Prime Farmland – Farmland with the best combination of physical and chemical features able to sustain long-term production of agricultural crops. This land has the soil quality, growing season, and moisture supply needed to produce sustained high yields.

Farmland of Statewide Importance – Farmland similar to Prime Farmland but with minor shortcomings, such as greater slopes or less ability to store soil moisture.

Unique Farmland – Farmland of lesser quality soils used for the production of the state's leading agricultural crops. This land is usually irrigated, but may include non-irrigated orchards or vineyards as found in some climatic zones in California.

Non-irrigated Farmland

Farmland of Local Importance – Land of importance to the local agricultural economy as determined by each county's board of supervisors and a local advisory committee.

Grazing Land – Land on which the existing vegetation is suited to the grazing of livestock. This category was developed in cooperation with the California Cattlemen's Association, University of California Cooperative Extension, and other groups interested in the extent of grazing activities (40-acre minimum mapping unit).

Other Land – Land not included in any other mapping category. Common examples include low density rural developments; brush, timber, wetland, and riparian areas not suitable for livestock grazing; vacant and nonagricultural land surrounded on all sides by urban development; confined livestock, poultry or aquaculture facilities; strip mines, borrow pits; and water bodies smaller than forty acres.

Farmland of Local Potential: Lands with Prime or Statewide soils that have potential for farming, but are not presently irrigated or cultivated (used only in Glenn, San Luis Obispo, and Yolo).

Interim Farmland Map Categories

For farmed areas lacking modern soil survey information and for which there is expressed local concern on the status of farmland, the following categories substitute for the categories of Prime (P), Statewide Importance (S), Unique (U), and Local Potential (L). This has included Butte, Colusa, and portions of Kern and Tulare Counties. With the completion of the Colusa and Western Tulare soil surveys, these areas were upgraded to Important Farmland status in 1998.

Irrigated Farmland (I)

Cropped land with a developed irrigation water supply that is dependable and of adequate quality. Land must have been used for production of irrigated crops at some time during the four years prior to the mapping date.

Non-irrigated Farmland (N)

Land on which agricultural commodities are produced on a continuing or cyclic basis utilizing stored soil moisture.

Appendix B: Glossary of Acronyms

CERES	California Environmental Resource Evaluation System
CDF	California Department of Forestry and Fire Protection
CDFA	California Department of Food and Agriculture
CDFG	California Department of Fish and Game
CNCCP	California Natural Communities Conservation Planning
CNDDB	California Natural Diversity Data Base
CURBA	California Urban and Biodiversity Analysis
FMMP	Farmland Mapping and Monitoring Program
FRAP	Fire and Resource Assessment Program
FRRAP	Forest & Rangeland Resources Assessment Program
RWRI	Rarity-weighted Richness Index
TPZ	Timber Production Zones
UCSB	University of California at Santa Barbara